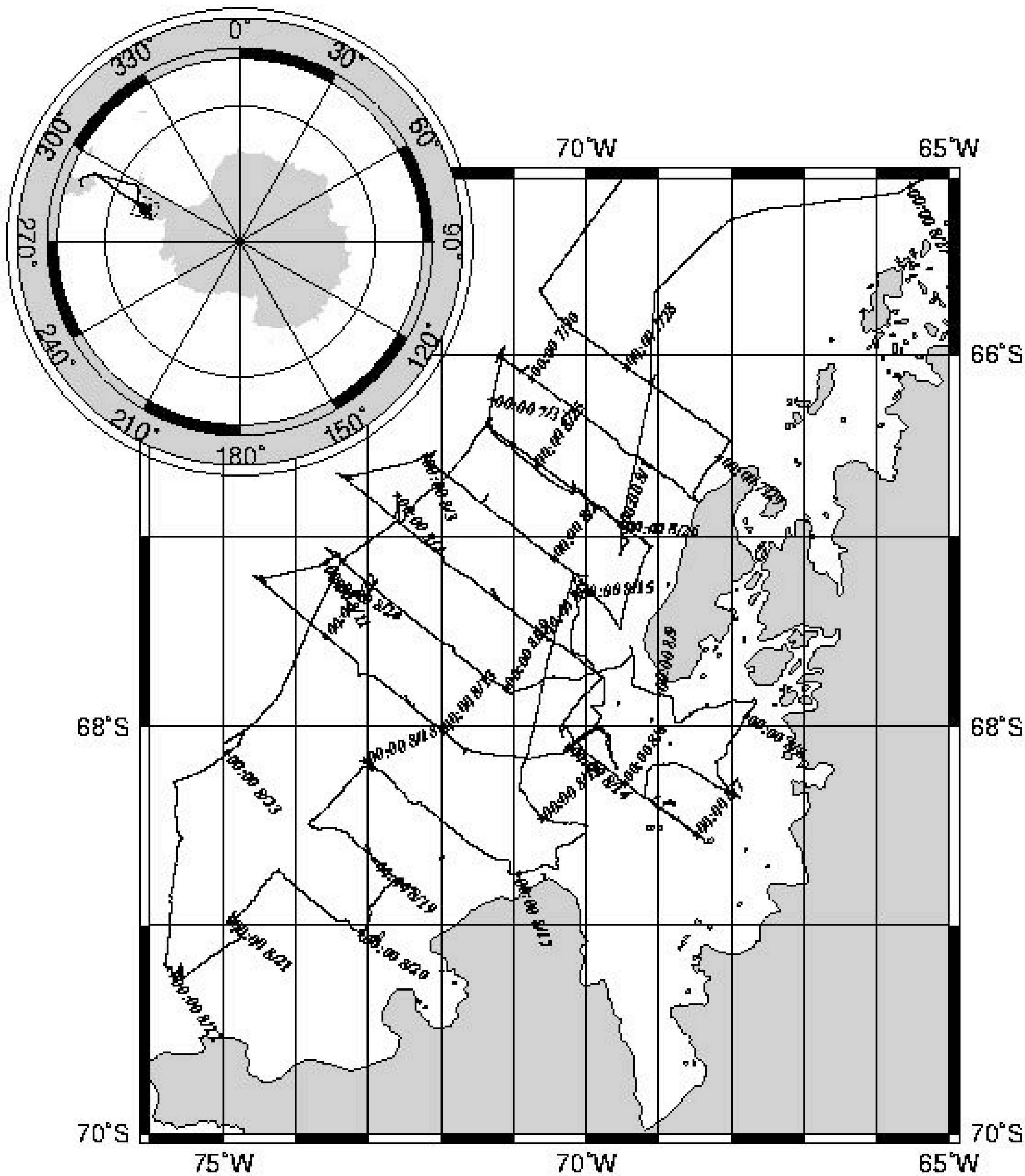
Data Report
NBP0104

GLOBEC II

July 22 – August 31, 2001



Prepared by: E. Joynt, T. Bolmer, and K. Gavahan

Introduction

The NBP data acquisition systems continuously log data from several instruments throughout the cruise. This document describes the format of that data and its location on the distribution media. It also contains important information which 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.

The data is contained in a Unix tar archives (.tar extension). All of the data has been compressed using Unix "gzip" compression. 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.

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. The tar files on the CD were created on an SGI using the following commands:

```
tar cvLf 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
```

The directories in the archive are structured in the following manner:

adcp/
    pingdata files
    config files
ctd/9909ctd.tar
geopdata/
    JGOF/<cruise_id>jg.tar
    PROC/<cruise_id>min.tar
        <cruise_id>sec.tar
        <cruise_id>mgd.tar
        <cruise_id>.tar
    ocean/<cruise_id>pCO_2.tar
imagery/TeraScan satellite images
NBP0104s.ps
NBP0104.ps
NBP0104.trk
NBP0104.mgd
NBP0104.gmt
rvdas/nav/<cruise_id>3df1.tar
        <cruise_id>adcp.tar
        <cruise_id>gyr1.tar
        <cruise_id>ngl1.tar
        <cruise_id>PCOD.tar
    uw/<cruise_id>bat1.tar
        <cruise_id>flr1.tar
        <cruise_id>met1.tar
        <cruise_id>oxyg.tar
        <cruise_id>p4co2.tar
        <cruise_id>sim1.tar
        <cruise_id>tsg1.tar
TSGcal
xbt/xbt files

Distribution Contents

ADCP

ADCP data during this cruise included additional data files that are not normally collected by this system. The additional size of these files necessitated distribution of the ADCP data on a separate CD set. Please refer to that CD data set.

CTD

The ctd data and report have been placed in the tar file 0104ctd.tar, which contains the flowing structure:

ctd.list (list of all ctd stations)
ctdsetup/ (batch files, cfg & con files)
data/ (raw datafiles)
plots/ (up & down trace postscript plots)
seasoft4.234/ (application for processing ctd data)
report/section/ (section plots)
casts/ (plots of individual casts)
text/ (ctd data report)
seacat/ (data structure for SeaCat ctd)

Individual CTD casts are 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 numbered according to the cruise id number (0104) followed by the number of the cast. For example; the raw files associated with the third cast on this cruise are: 0104003.bl, 0104003.con, 0104003.dat, 0104003.hdr. The raw and processed data files are in binary format. The 1 db bin averaged up and down traces have been converted to ascii (.asc files).

SeaBird's SeaSoft software used to acquire the data is included in the CTD data distribution in the "Seasoft" directory. SeaSoft is a DOS-based software package, but can be run in a DOS window under the Windows9X operating systems for cast playback and data analysis. The software package used to process this data (version 4.234) is included on this CD in the directory **Seasoft**. The configuration files and processing scripts (written by Suzanne O'Hara for the standard processing of the SBE 9/11*plus*) are also included in the **Seasoft** directory under in the **ctdsetup** directory. The directory **report** contains the CTD data report with folder for all plots produced during the cruise. The directory **seacat** gas a structure similar to the ctd directory and contains the data from the SeaCat CTD unit.

File extension definitions:

EXT	**Description**
ASC	The data portion of a .CNV converted data file written in ASCII by ASCIIOUT, or files written by TERM37.
BL	Created by SEASAVE when a bottle fire confirmation is received. Contains bottle sequence number, position, date, time, beginning and ending scan numbers.
BTL	Created by ROSSUM. This is a summary of the data in a .ROS file.
BSR	Bottle scan range file, used by DATCNV to create a .ROS file.
CFG	Used by SEASOFT modules to store the input filename, input data path, output data path, and other miscellaneous module specific parameters.
CTR	Density contour file generated by CONTOUR.
CNV	'Converted' engineering unit data file. An ASCII header precedes the data.
CON	Contains instrument configuration and calibration coefficients, used by SEACON, SEASAVE, and DATCNV
DAT	Raw binary data, optionally with header information (SBE 9/11, 11X, 9/11*plus*, and data files created with previous versions of SEASOFT).
DSP	Used by SEASAVE to store data acquisition and display parameters.
HDR	R. Header portion of a .CNV converted data file written by ASCIIOUT. 2) Header recorded when acquiring real time data or uploading archived data.
HEX	Raw HEX data with header information (SBE 16, 17, 19, 21, and 25)
MRK	Marker file created by SEASAVE during real time data acquisition.
PLT	Used by SEAPLOT to store display parameters
ROS	Scans marked with the bottle fire confirmation bit, or defined by a .BSR file, written by DATCNV.

*Note: This is a complete list of all file extensions. This data set may not contain ALL of the above extension files.

SEASOFT modules search the current directory for DSP, PLT, and CFG files. SEASOFT modules search the 'input data path' for CON, HEX, DAT, and CNV files. One exception is SEACON which searches the current directory for CON files.

For more information and updated software visit the web site at www.seabird.com; or contact (206) 643-9866, seabird@seabird.com, Sea-Bird Electronics 1808 – 136th Place NE Bellevue, WA 98005

Cruise Tracks

/plots

PostScript cruise track and station plots have been produced for this cruise:

- Cast locations: 0104casts.ps
- Tow Locations: 0104tows.ps
- Cruise Track: 0104trk.ps
- Letter size, all stations: 0104all.ps
- Letter Size, bathymetry: bathsmall.ps
- Poster size, all stations: posterall.ps
- Poster size, bathymetry: posterbat.ps

GUV

All files are placed in two zip-archives named puv.zip and guv.zip. The contents of the archives are in the files puvlst.txt and guvlst.txt respectively. GUV data was acquired continuously from the instrument mounted on the top of the science mast until the end of data collection fo rthe cruise. PUV data consists of a single cast on most days. A copy of the PUV/GUV calibration file used for Biospherical Instruments' PUV500 acquisition software is included in the puvguv directory on CD1 as calibr8.puv.

The PUV files were converted to CSV (Comma Separated Value) format using the Biospherical Instruments' PUVLOG program. Similarly, the GUV files were converted to CSV format using the Biospherical Instruments' PUVPROF program. For additional information on the PUV/GUV data collected during NBP9901, contact:

Dr. Chris Fritzen, at cfritsen@dri.edu cfritsen@dri.edu or at: University and Community College System of Nevada, Desert Research Institute, Biological Sciences Center, 7010 Dandini Blvd, Reno, NV 89512, USA (715) 673-7487.

The columnar format of the CSV file is listed below:

Field	PUV Data
1	Depth
2	308 U
3	320 U
4	Temp U
5	MATFL
6	340 U
7	380 U
8	PAR U
9	Temp U
10	308 S
11	Batt S
12	320
13	340
14	380
15	Gnd
16	PAR
17	K308
18	K320

Field	GUV Data
1	Depth
2	306 U
3	320 U
4	Temp U
5	MATFL
6	340 U
7	380 U
8	PAR U
9	Temp S
10	300 S
11	Batt S
12	320 S
13	340 S
14	380 S
15	Gnd S
16	PAR S

19	K340
20	K380
21	Kpar
22	Chl
23	Prod

Satellite Images

/imagery

Satellite Images processed for this cruise were organized into three folders cwifs, ice and wx for the different types of TeraScan products. Files were named in the following convention:

IDJJJYYA.jpg where:

ID = imge type (is = ice ssmi, iv = ice visible, cw = seawifs, wx = weather)
JJJ = Julian day
YY = year
A = used to allow for multiple images of type for that day

Science Report

/reports

The daily science reports in html format.

NBP Data Products: MGD77 & JGOFS

NBP0104.mgd
NBP0104.gmt
/geopdata/0104jgof.tar
/geopdata/0104mgd.tar

Two data products are created on each cruise of the NBP: JGOFS and MGD77. Also, included in the PROC directory are interim process files of some of the data. These are useful if it is necessary to reporcess the data through the RVDAS daily processing routines.

JGOFS

The JGOFS data set consists of a single file produced each day named jgDDD.dat.gz where DDD is the Julian day the data was acquired. The ".gz" extension indicates that the individual files are compressed before archiving. The daily file consists of 20 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. For example, Course Made Good (CMG) and Speed Over Ground (SOG) are calculated from gyro and GPS inputs by the NGL software package. Similarly, the wind direction field is the vector sum of the separate X and Y inputs received from the wind instrument. The JGOFS data set was used to produce the daily data plots during the cruise. *Note: Null, unused, or unknown fields are filled with 9's in the JGOFS data. TSG data is processed by RVDAS.*

Field	Data	Units
01	GMT date	dd/mm/yy
02	GMT time	hh:mm:ss
03	NGL latitude (negative is South)	dd.dddd
04	NGL longitude (negative is West)	ddd.dddd
05	Speed over ground	Knots
06	GPS HDOP	-
07	Gyro Heading	Degrees (azimuth)
08	Course made good	Degrees (azimuth)
09	mast PAR	μEinsteins/meters^2 sec
10	sea surface temperature	°C

Field	Data	Units
11	sea surface conductivity	siemens/meter
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

MGD77

The MGD77 data set is contained in a single file for the entire cruise named NBP0104.mgd, There is also a file named NBP0104.gmt. This file is the output of the mgd77togmt utility using NBP0104.mgd as input. The "gmt" file can be useful for plotting data using the GMT plotting package. The directory /geopdata/PROC contains a file from each day of data acquisition named: Dddd.fnl.gz, where ddd is the Julian day. These files contain all the data used to produce the "mgd" file, but in a space-delimited columnar format that may be more accessible for some purposes. In addition, these files contain data at one-second intervals rather than one minute and are individually "gzipped" to save space. Below is a detailed description of the MGD77 data set format.

All decimal points are implied. Leading zeros and blanks are equivalent. Unknown or unused fields are to be filled with 9's. All "corrections", such as time zone, diurnal magnetics, and Eotvos, are understood to be added.

Col	Len	Type	Description
1	1	int	DATA RECORD TYPE Set to "3" for data record.
2-9	8	char	SURVEY IDENTIFIER
10-14	5	int	TIME-ZONE CORRECTION: In hundredths of hours. Corrects time (in characters 13-27) to GMT when added: equals zero when time is GMT.
15-16	2	int	YEAR 2 digit year
17-18	2	int	MONTH (e.g. May is represented as 05)
19-20	2	int	DAY Day of month
21-22	2	int	HOUR
23-27	5	real	MINUTES X 1000
28-35	8	real	LATITUDE X 100000 + = North; - = South. (–9000000 to 9000000)
36-44	9	real	LONGITUDE X 100000 + = East; - = West. (–18000000 to 18000000)
45	1	int	POSITION TYPE CODE: 1=Observed fix; 3=Interpolated; 9=Unspecified
46-51	6	real	BATHYMETRY, 2- WAY TRAVELTIME: In 10,000th of seconds. Corrected for transducer depth and other such corrections
52-57	6	real	BATHYMETRY, CORRECTED DEPTH: In tenths of meters.
58-59	2	int	BATHYMETRIC CORRECTION CODE: This code details the procedure used for determining the sound velocity correction to depth
60	1	int	BATHYMETRIC TYPE CODE: 1 = Observed; 3 = Interpolated (Header Seq. 12); 9 = Unspecified
61-66	6	real	MAGNETICS TOTAL FIELD, 1ST SENSOR: In tenths of nanoteslas (gammas).
67-72	6	real	MAGNETICS TOTAL FIELD, 2ND SENSOR: In tenths of nanoteslas (gammas). For trailing sensor.
73-78	6	real	MAGNETICS RESIDUAL FIELD: In tenths of nanoteslas (gammas). The reference field used is in Header Seq. 13.
79	1	int	SENSOR FOR RESIDUAL FIELD

Col	Len	Type	Description
			1 = 1st or leading sensor; 2 = 2nd or trailing sensor; 9 = Unspecified
80-84	5	real	MAGNETICS DIURNAL CORRECTION: In tenths of nanoteslas (gammas). (In nanoteslas) if 9-filled (i.e., set to "+9999"), total and residual fields are assumed to be uncorrected; if used, total and residuals are assumed to have been already corrected.
85-90	6	F6.0	DEPTH OR ALTITUDE OF MAGNETICS SENSOR: In meters. + = Below sea level 3 = Above sea level
91-9	7	real	OBSERVED GRAVITY: In 10th of mgals. Corrected for Eotvos, drift, tares.
98-10	6	real	EOTVOS CORRECTION: In tenths of mgals. E = 7.5 V cos phi sin alpha + 0.0042 V*V
104-108	5	real	FREE-AIR ANOMALY In tenths of milligals Free-air Anomaly = G(observed) – G(theoretical)
109-113	5	char	SEISMIC LINE NUMBER: Used for cross-referencing with seismic data.
114-119	6	char	SEISMIC SHOT-POINT NUMBER
120	1	int	QUALITY CODE FOR NAVIGATION: 5=Suspected, by the originating institution;6=Suspected, by the data center, 9=No identifiable problem found

RVDAS

/rvdas/uw
/rvdas/nav

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.

Daily data processing of the RVDAS data is performed to convert values into uasable units and as a check of the proper operation of the DAS. Both the raw and processed data sets from RVDAS are included in the data distribution. 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	met1	continuous	1 sec	R. M. young 41372LC/LF
Relative Humidity	met1	continuous	1 sec	
Wind Speed/Direction	met1	continuous	1 sec	R.M. Young 05106
Barometer	bar1	continuous	1 sec	R.M. Young 61201
PIR (LW radiation)	met1	continuous	1 sec	Eppley PIR
PSP (SW radiation)	met1	continuous	1 sec	Eppley PSP
PAR	met1	continuous	1 sec	BSI QSR-240
GUV		continuous		BSI PUV-511A

Navigational Data

Measurement	File ID	Collect. Status	Rate	Instrument
Attitude GPS	3df1	continuous	1 sec	Ashtec 12
P-Code GPS	PCOD	continuous	1 sec	Trimble 20636-00SM
Gyro	gyr1	continuous	0.2 sec	Yokogawa Gyro
NGL	ngl1	continuous	1 sec	NGL Processed Nav Data

Geophysical Data

Measurement	File ID	Collect. Status	Rate	Instrument
Gravimeter	grv1	continuous	10 sec	Lacoste & Romberg Gravity
Magnetometer	mag1	not collected	15 sec	EG&G G-866
Bathymetry	bat1	continuous	Varies	ODEC Bathy 2000
Bathymetry	sim1	depth < 2500 m	Varies	Simrad EK200 Sonar

Bathymetry	knu1	not collected	varies	Knudsen

Oceanographic Data

Measurement	File ID	Collect. Status	Rate	Instrument
Conductivty	tsg1	continuous	6 sec	SeaBird 21
Salinity	tsgfl	continuous	6 sec	calculated PSS78
Sea Surf. Temperature	tsg1	continuous	6 sec	SeaBird 3-01/S
Fluorometry	flr1 & tsg1	continuous	6 sec	Turner 10-AU-005
Transmissometry	tsg1	continuous	6 sec	WET Lab C-Star
pCO_2	pco2	continuous	70 sec	
ADCP	adcp	continuous	varies	RD Instruments

Data File Names and Structures

RVDAS data is divided into two broad categories, ***Underway*** and ***Navigation***. The groups are abbreviated “uw” and “nav”. These two subdirectories exist under the top-level rvdas directory. The instruments are broken down as shown. Each data file is gzipped to save space on the distribution. Not all data types are collected every day or on every cruise.

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

- The CruiseID is the numeric name of the cruise, for example: NBP0104.
- The FileID (aka Channel ID) is a 4-character code representing the system being logged, for example: met1 (for meteorology)
- DDD is the year day of the data collection

Underway Data	Channel ID
Barometer	bar1
Bathy 2000	bat1
Fluorometer	flr1
Gravimeter	grv1
Magnetometer	mag1
Meteorological	met1
Simrad	sim1
Thermosalinograph	tsg1
PCO_2	pco2
Knudsen	knud

Navigation Data	Channel ID
Ashtech GPS	3df1
Trimble GPS (P-Code)	PCOD
Gyro Compass	gyr1
Furuno GPS	gp02
NGL	ngl1
ADCP course	adcp

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 delimters 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 field’s separations are clearly understood. An example data

bat1

```
00+019:23:59:53.901 ;I04485.3ME-23.0,I00000.0,-99.9, 0000@01/11/00,23:59:52.08 PW2 PF1 SF1 PL3
MO4 SB3 PO0 TX1 TR: GM5 1500 06.7 -72.1
```

Field	Data	Units
1	RVDAS Time Tag	
2	Flagged Low Freq. Chn. Depth w/ units ;FDDDDD.DUN F= V valid, I invalid	meters
3	Low Freq. Echo Strength EEE.EE	dB

Field	Data	Units
4	Flagged High Freq. Chn. Depth – unused	
5	High Freq. Echo Strength – unused	
6	Signed Heave Data SHHHH	cm
7	Date	mm/dd/yy
8	Time	hh:mm:ss
9	transmit pulse window type: PW1 Rectangular, PW2 Hamming, PW3 Cosine, PW4 Blackman	
10	Primary transmit frequency PF1 3.5 kHz, PF2 12.0 kHz	
11	Parametric mode secondary freq. SF1 3.5 kHz, SF2 12.0 kHz	
12	pulse length: PL1 200usec, PL2 500usec, PL3 1msec, PL4 2msec, PL5 5msec, PL6 10msec, PL7 25msec. If transmit mode is FM: PL1 25msec, PL2 50msec, PL3 100msec.	
13	Operating Mode: MO1 CW parametric, MO2 CW, MO3 FM parametric, MO4 FM	
14	Frequency sweep bandwidth: SB1 1 kHz, SB2 2 kHz, SB3 5 kHz	
15	power level: PO1 0dB, PO2 -6dB, PO3 -12dB, PO4 -18dB, PO5 -24dB, PO6 -30dB, PO6 -30 dB, PO7 -36dB, PO8 -42dB	
16	Transmit Mode: TX1 single ping active, TX2 pinger listen, TX3 multipinging TR, TX4 multipinging TR, TX5 multipinging TTRR, TX6 mulitpinging TTTTRRRR, TX7 mulitpinging TTTTTRRRRR	
17	Transmit Rate: TR3 4Hz, TR4 2Hz, TR5 1Hz, TR6 .5Hz, TR7 .33Hz, TR8 .25Hz, TR9 .20Hz, TR: = .10Hz, TR; = .05Hz	
18	System Gain Mode: GM0 hydrographic AGC, GM1 to GM9 hydrographic +3db to + 27db manual. GMA to GMD hydrographic + 30db through + 60db manual, GME to GMK sub-bottom 1 through sub-bottom 7	
19	speed of sound	m/sec
20	depth of sonar window below sea-level	meters
21	background noise level in fixed point reference	dB/V

flr1

```
00+019:23:59:58.061 0  0818 ::  1/19/00 17:23:17 = 0.983  (RAW)   1.2 (C)
```

Field	Data	Units
1	RVDAS Time Tag	
2	marker 0 to 8	
3	4-digit index	
4	date	mm/dd/yy
5	time	hh:mm:ss
6	signal	
7	signal units of measurement	
8	cell temperature	
9	temperature units	

grv1

```
99+099:00:18:19.775 your_line#1999 99 01818 9735.4
```

Field	Data	Units	Conversion
1	RVDAS Time Tag		
2	text string		
3	gravity device date	yyyyjjjhhmmss	
3	gravity count	count	mgal = count x 1.0047 + offset

knud

```
99+099:00:18:19.775 hf,305.2,lf,304.3
```

Field	Data	Units
1	RVDAS Time Tag	
2	hf – high frequency flag (12 kHz)	
3	high fequency depth	meters

Field	Data	Units
4	lf – low frequency flag (3.5 kHz)	
5	low frequency depth	meters

mag1

```
99+099:00:00:23.203 %  0  98 235928    0?372453
```

Field	Data	Units
1	RVDAS Time Tag	
2	% 0 denotes G-866 magnetometer	
3	Julian Day	
4	Time	
5	0? denotes high noise condition	
6	Magnetic Data (last digit is 10^{th}'s place)	nT

met1

```
00+019:23:59:59.761 $MET:  0.84, 1.12, 0.76, 1.06, 4.98, 0.26, 1.49, 3.93, 8.94, 0.80, 0.01,
0.01, 0.01, 0.22, 0.02, 0.1,40.11,4.96
```

Field	Data	Units	Conversion
1	RVDAS Time Tag		
2	Port windbird Speed (relative)	m/s	
3	Port windbird Direction (relative)	deg	
4	Port windbird standard deviation	deg	
5	Starboard windbird Speed (relative)	m/s	
6	Starboard windbird Direction (relative)	deg	
7	Starboard windbird standard deviation	deg	
8	Barometer	mBar	
9	Air Temperature	°C	
10	Relative Humidity	%	
11	PSP (short wave radiation)	mV	see calc. section
12	PIR (long wave radiation)	mV	see calc. section
13	PAR (photosyntheticly available radiation)	mV	see calc section

pCO_2

```
00+021:23:59:43.190 2000021.9992 2382.4 984.2 30.73 50.8 345.9 334.1 -1.70 -68.046 -144.446 Equil
```

Field	Data	Units
1	RVDAS Time Tag	
2	pCO_2 Time Tag (decimal is time of day)	yyyjdd.fod
3	raw voltage	mV
4	barometer	mBar
5	cell temperature	°C
6	flow rate	cm^3/min
7	concentration	ppm
8	pCO_2 pressure	microAtm
9	Equilibrated temperature	°C
10	Latitude	degrees
11	Longitude	degrees
12	Flow Source (Equil = pCO_2 measurement)	

sim1

```
00+005:00:00:52.388 D1,23583509,1479.6, 17,  1,  0
```

Field	Data	Units
1	RVDAS Time Tag	
2	Header	
3	Time Tag	hhmmss.sss

Field	Data	Units
4	Depth	m
5	bottom surface backscattering strength	dBar
6	Transducer number (1 = 38 kHz)	
7		

stc1

```
00+019:23:59:46.976 ##ryyyydddhhmmssuuuuuuSSCC
00+347:00:00:05.013 ##BFFFF3470000049568311529
```

Field	Data	Units
1	RVDAS Time Tag	
2	r is the input time code "B" for IRIG-B	
3	yyyy is the year (FFFF if IRIG input)	
4	ddd is the 3 digit day of the year	
5	hh is 2 digit hour of day	
6	mm is 2 digit minute of hour	
7	ss is 2 digit second of minute	
8	uuuuuu is 6 digits for microseconds digits	
9	SS is 2 hex character DP-Extd_Sts dual port RAM value	
10	CC is checksum	

svp1

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

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

syn1

```
00+120:10:46:30.665 *GCS900228     005   811.00001E00/04/29:10:45:53110606000000000403000-
0.050.023    00000000-00101AP1N 000156498-0100002AP1N 00016350100100003AP1N 000162497-0200004AP1N
00015850000000005AP1N 00015550100100006AP1N 000157500000000
```

Field	Data	Units
1	RVDAS Time Tag	
2	String tag	
3	Number of bytes	
4	Line number	
5	Shotpoint number	

tsg1

```
00+019:23:59:46.976 15A16CFC163F8C2C100
```

Field	Data	Units
1	RVDAS Time Tag	
2	Seabird Hex string (see notes on converting to real units)	

3df1

PBEN: Measurement Data

```
00+019:23:59:57.054 $PASHR,PBN,345609.00,-1695527.0,-1569301.4,-5925126.0,-068:49.6968,-
137:12.8448,00047.7,-000.69,000.67,-000.51,08,????,02,01,02,01*32
```

Field	Data	Units
1	RVDAS Time Tag $PASHR	
2	PBN	
3	GPS Time sec. of the week	seconds
4	Station Postion: ECEF X	meters
5	Station Postion: ECEF Y	meters

Field	Data	Units
6	Station Postion: ECEF Z	meters
7	Latitude (- = South)	deg:min
8	Longitude (- = West)	deg:min
9	Altitude	meters
10	Velocity in ECEF X	m/sec
11	Velocity in ECEF Y	m/sec
12	Velofity in ECEF Z	m/sec
13	Number of satellites used	
14	Site name	
15	PDOP	
16	HDOP	
17	VDOP	
18	TDOP	

ATTD: Attitude Data

```
00+019:23:59:57.854 $PASHR,ATT,345610.0,252.82,+000.52,+001.95,0.0011,0.0068,0
```

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	Measuremnet RMS error	meters
8	Baseline RMS error	meters
9	Attitude reset flag	

GGA: GPS Position Fix – Geoid/Ellipsoid

```
00+019:23:59:57.134 $GPGGA,235956.00,6849.6968,S,13712.8448,W,1,08,01.0,+00048,M,,M,,
```

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	
15	Differential reference station ID	

gyr1

```
00+019:23:59:59.952 $HEHRC25034,-020*73
```

Field	Data	Units
1	RVDAS Time Tag	
2	$HEHRC	
3	Heading XXXXX = ddd.dd	degrees
4	Rate of Change SYYY S = +/-, YYY = r.rr	

Field	Data	Units
5	Checksum	

ngl1

```
00+019:23:59:59.857 -68.82822,-137.21416,1.10,279.27,251.10,0.00,0.00,0,18.2587,1,1146973
```

Field	Data	Units
1	RVDAS Time Tag	
2	Latitude (south is negative)	degrees
3	Longitude (west is negative)	degrees
4	Ship Speed	knots
5	Course made good	degrees
6	Gyro Heading	degrees
7	PDOP	
8	HDOP	
9	Quality	
10	GPS up	
11	Fix Number	

PCOD

GGA: GPS Position Fix – Geoid/Ellipsoid

```
00+019:23:59:59.301 $GPGGA,235958.409,6849.6944,S,13712.8472,W,1,06,1.2,092.4,M,047.3,M,,*67
```

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

GLL: GPS Latitude/Longitude

```
00+019:23:59:59.381 $GPGLL,6849.6944,S,13712.8472,W,235958.409,A*35
```

Field	Data	Units
1	RVDAS Time Tag	
2	$GPGLL	
3	Latitude	degrees
4	North or South	
5	Longitude	degrees
6	East or West	
7	UTC of position	hhmmss.sss
8	Staus of data (A = valid)	
9	Checksum	

VTG: GPS Track and Ground Speed

```
00+019:23:59:59.382 $GPVTG,238.7,T,182.3,M,001.8,N,003.3,K*41
```

Field	Data	Units
1	RVDAS Time Tag	
2	$GPVTG	
3	Heading	degrees
4	Degrees True (T)	
5	Heading	degrees
6	Degrees magnetic (M)	
7	Ship speed	knots
8	N = knots	
9	Speed	km/hr
10	K = km per hour	
11	Checksum	

adcp

```
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, East vector	kn
5	Ship Speed relative to reference layer, North vector	kn
6	Ship heading	degrres

Ocean Data Files

ocean/

pCO2-merged

```
00+346:23:58:20.672 2000346.9991 2398.4 1008.4 0.01 45.4 350.3 342.6 15.77 Equil -43.6826
173.1997 15.51 33.90 0.33 5.28 9.05 1007.57 40.0 14.87 182.44
```

Field	Data	Units
1	RVDAS Time Tag	
2	PCO_2 Time Tag (decimal is time of day)	yyyjdd.fod
3	raw voltage	mV
4	Barometer	mB
5	cell temperature	°C
6	flow rate	cm^3/min
7	Concentration	ppm
8	PCO_2 pressure	microAtm
9	Equilibrated temperature	°C
10	Flow Source (Equil = pCO_2 measurement)	
11	RVDAS latitude	degrees
12	RVDAS longitude	degrees
13	TSG external temperature	°C
14	TSG salinity	PSU
15	TSG fluorometry	V
16	RVDAS true wind speed	m/s
17	RVDAS true wind direction	degrees
18	Barometric Pressure	Mbars
19	Uncontaminated seawater pump flow rate	l/min
20	Speed over ground	Knots
21	Course made good	Degrees

tsgfl

```
00+075:00:00:04.467 -01.488 -01.720 02.6783 33.63748 1.002442 0.002442
```

Field	Data	Units
1	RVDAS Time Tag	
2	Internal water temperature	°C
3	Sea Surface Temperature	°C
4	Conductivity	µSiemens
5	Salinity	PSU
6	Fluorometry	V
7	Transmissometer	V

xbt

0104xbt.tar

During the cruise Expendable Bathythermographs were used to obtain water column temperature profiles. These were used to adjust the sound velocity profile for the SeaBeam system. The data files from these launches are included.

Calculations

TSG

Raw TSG data is stored as a 20 byte (character) long hex string

Bytes	Data
1-4	Sensor Temperature
5-8	Conductivity
9-14	Remote Temperature
15-17	Fluorometer voltage
18-20	Transmissometer voltage

The coefficients for temperature and conductivity sensors can be found in the calibrations section..

Calculating Temperature – ITS-90

T = decimal equivalent of bytes 1-4

Temperature Frequency: f = T/19 +2100

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

Calculating Conductivity – ITS-90

C = decimal equivalent of bytes 5-8

Conductivity Frequency f = sqrt(C*2100+6250000)

$$\text{Conductivity} = (g + hf^2 + if^3 + jf^4)/[10(1 + \delta t + \epsilon p)] \ \text{(siemens/meter)}$$

t = temperature (°C); p = pressure (decibars); δ = Ctcor; ϵ = CPcor

Calculating Fluorometry Voltage

f = decimal equivalent of bytes 15-17

Fluorometry Voltage = f/819

Calculating Transmittance

V_{dark} = 0.058 V

V_{ref} = 4.765 V

t = decimal equivalent of bytes 18 – 20

Transmissometer Voltage (V_{signal}) = t/819

$$\% \text{ Transmittance} = (V_{signal} - V_{dark}) / (V_{ref} - V_{dark})$$

PAR

raw data = mV

calibration scale = 6.08 V/(μEinstiens/cm ^{2}sec)

offset (V_{dark}) = 0.3 mV

$(raw \text{ mV} - V_{dark})/\text{scale} \times 10^4 \text{ cm}^2/\text{m}^2 \times 10^{-3} \text{ V/mV} = \mu\text{Einstiens/m}^2\text{sec}$

or

$(data \text{ mV} - 0.3 \text{ mV}) \times 1.65 \ (\mu\text{Einstiens/m}^2\text{sec})/\text{mV} = \mu\text{Einstiens/m}^2\text{sec}$

PIR

raw data = mV

calibration scale = 4.13×10^{-6} V/(W/m^2)

$data \text{ mV} / (\text{scale} \times 10^3 \text{ mV/V}) = \text{W/m}^2$

or

$data \text{ mV} \times 242.1(\text{W/m}^2)/\text{mV} = \text{W/m}^2$

PSP

raw data = mV

calibration scale = 8.28×10^{-6} V/(W/m^2)

$data \text{ mV} / (\text{scale} \times 10^3 \text{ mV/V}) = \text{W/m}^2$

or

$data \text{ mV} \times 120.7 \ (\text{W/m}^2)/\text{V} = \text{W/m}^2$

NBP0104 Sensors

Shipboard Sensors

Sensor	Description	Serial #	Cal. Date	Status
Port Anemometer	RM Young 5106	WM46262	4/11/01	collect
Stbd Anemometer	RM Young 5106	WM46263	4/11/01	collect
Barometer	RM Young 61201	01705		collect
Air Temp/Rel. Hum.	RM Young 41372LC	06134		
Mast PRR	BSI PRR-610			not collect
UW PRR	BSI PRR-600			not collect
Mast PAR	BSI QSR-240	6356	2/15/01	collect
Pyranometer	Eppley PSP	33090F3	11/7/00	collect
Pyrgeometer	Eppley PIR	32845F3	2/22/01	collect
P-Code GPS	Trimble 20636-00 (SM)			PCD/CIV
Attitude GPS	Ashtech 12	700273F2114 FW 7B13-D1-C21		collect
TSG	SeaBird SBE21	214857-0857	2/7/01	collect
TSG Remote Temp	SeaBird 3-01/S	032593	1/3/01	collect
Fluorometer	Turner 10-AU-005 Lamp: daylight 10-045; ref. filter: 10-052, em. filter: 10-051, ex. filter: 10-050	5651 FRTD		collect
Transmissometer	WET Labs C-Star	CST-422PR	1/2/01	collect
Magnetometer	EG&G G-866			not collect
Gravimeter	Lacoste & Romberg Gravity Meter			collect
Bathymetry	Simrad EK500	3001	11/1/95	collect
Bathymetry	Bathy 2000			collect

NBP0104 CTD Sensors:

Sensor	Description	Serial Number	Cal. Date
CTD Fish	SeaBird model SBE 9+	94857-0232	
Pressure Sensor	Digiquartz 410K-105	43528	2/13/01
CTD Deck Unit	SeaBird model SBE 11+	11P7536-0317	
Primary Temperature Sensor	SeaBird model 3plus 6800m	03P2168	8/20/99
Secondary Temperature Sensor	SeaBird model 3plus	03P2186	7/20/00
Primary Conductivity Sensor	SeaBird model 4-02/0	041143	9/19/00
Secondary Conductivity Sensor	SeaBird model 4C	040924	
Dissolved Oxygen Sensor	SeaBird model 13-02-B	130295	7/21/00
Fluorometer	Chelsea model Mk III Aquatracka	088080	7/16/01

NBP0104 MOCNESS Sensors:

Sensor	Description	Serial Number	Cal. Date
1 m^2 MOCNESS			
Conductivity	Sea-Bird 4C	42067	2/13/01
MOC. Electronics/Press. Sensor	B.E.S.S. 16Bit	0148	2/24/01
Optical Plankton Counter	Focal Technologies OPC-1T	TOW031	8/1/96?
Temperature	Sea-Bird 3+	3P2438	2/14/01
Transmissometer	WET Labs C-Star	CST-439DR	2/28/01
Fluorometer	WET Labs AFL	AFL-016D	2/21/01
10 m^2 MOCNESS			
MOC. Electronics/Press. Sensor	B.E.S.S. 16Bit	0149	2/24/01
Conductivity	Sea-Bird 4C 6800m	41852	2/13/01
Temperature	Sea-Bird 3plus 6800m	03P2308	2/13/01

Acquisition Problems and Events

This section lists all known problems with acquisition during this cruise including instrument failures, data acquisition system failures and any other factor affecting this data set. The format is jjj:hh:mm (jjj is julian day, hh is hour, and mm is minute). All times are in GMT.

Start	End	Description
203:		Start of Nav and Met data collection
204:13:00		Start of TSG and ADCP data collection
206:04:08		Outside 200-mi limit
207:14:30	208:02:00	Air Temp. reading failed. Cause was a misformatting of output string from RM Young translator. Output format has been modified.
207:14:30	208:02:30	Rmeote and Intenral Seawater temperature readings were non-correleated. Cause was a mixing in of sea wtaer form another intake system in between the two temp. sensors.
217:02:00	218:03:00	Rel. Humidity sesnor had frosted over giving readings > 100%
241:		200-mi limit, end archive of geophysical data
242:		End of permit for ADPC/TSG data collection

Calibrations

The file *instrument.coef* contains the calibration factors for the shipboard instruments. This file is used by the RVDAS processing software in calculations of the using the raw data.

TSG CALIBRATION FILES

Conductivity Sensor

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

SENSOR SERIAL NUMBER = 857
CALIBRATION DATE: 07-Feb-01

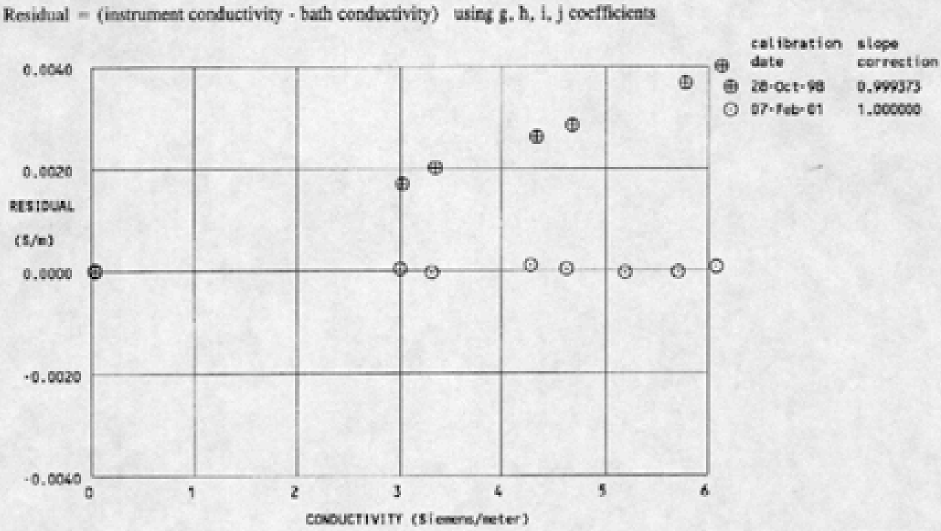
CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

GHIJ COEFFICIENTS
g = -4.05724357e+00
h = 4.84226382e-01
i = 1.14515552e-03
j = -2.84005419e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

ABCDM COEFFICIENTS
a = 4.78926301e-02
b = 4.32368827e-01
c = -4.04137716e+00
d = -1.12306086e-04
m = 2.1
CPcor = -9.57e-08 (nominal)

BATH TEMP (ITS-90 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88550	0.00000	0.00000
1.0001	34.6653	2.96429	8.27829	2.96430	0.00001
4.4999	34.6654	3.27188	8.64565	3.27183	-0.00005
14.9999	34.6641	4.25490	9.72645	4.25499	0.00009
18.5000	34.6631	4.60023	10.07823	4.60024	0.00001
24.0000	34.6604	5.15799	10.62162	5.15793	-0.00006
28.9999	34.6558	5.67898	11.10502	5.67893	-0.00005
32.4998	34.6481	6.04995	11.43675	6.05000	0.00005

Conductivity = $(g + hf^2 + if^3 + jf^4) / [10(1 + \delta t + \epsilon p)]$ Siemens/meter
Conductivity = $(af^m + bf^2 + c + dt) / [10(1 + \epsilon p)]$ Siemens/meter
t = temperature [deg C]; p = pressure [decibars]; δ = CTcor; ϵ = CPcor;
Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



POST CRUISE CALIBRATION

Temperature

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 857
CALIBRATION DATE: 07-Feb-01

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.24096327e-03
h = 5.99514049e-04
i = 4.88339043e-06
j = -1.67667318e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.64763319e-03
b = 5.84843916e-04
c = 9.94146384e-06
d = -1.67615257e-06
f_0 = 2720.016

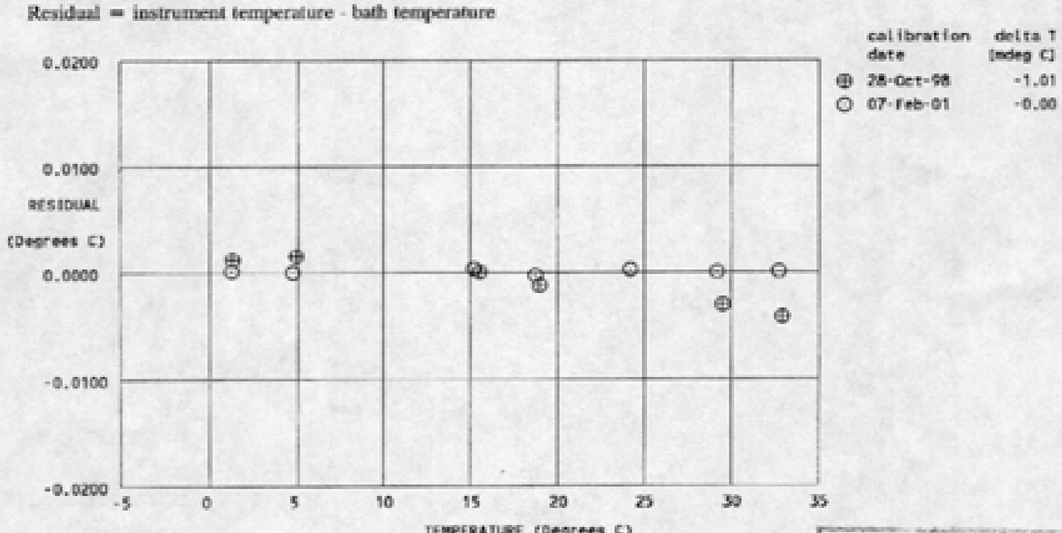
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
1.0001	2720.016	1.0001	0.00003
4.4999	2942.848	4.4998	-0.00007
14.9999	3689.140	15.0002	0.00025
18.5000	3965.047	18.4997	-0.00033
24.0000	4427.621	24.0002	0.00016
28.9999	4879.819	28.9998	-0.00006
32.4998	5214.974	32.4998	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



POST CRUISE CALIBRATION

Remote Temperature

TSG extended

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

SENSOR SERIAL NUMBER = 2593
CALIBRATION DATE: 03-Jan-01s

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.27987204e-03
h = 6.19581534e-04
i = 2.06356990e-05
j = 1.60635055e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.67988692e-03
b = 5.83301097e-04
c = 1.58473443e-05
d = 1.60775530e-06
f_0 = 2715.661

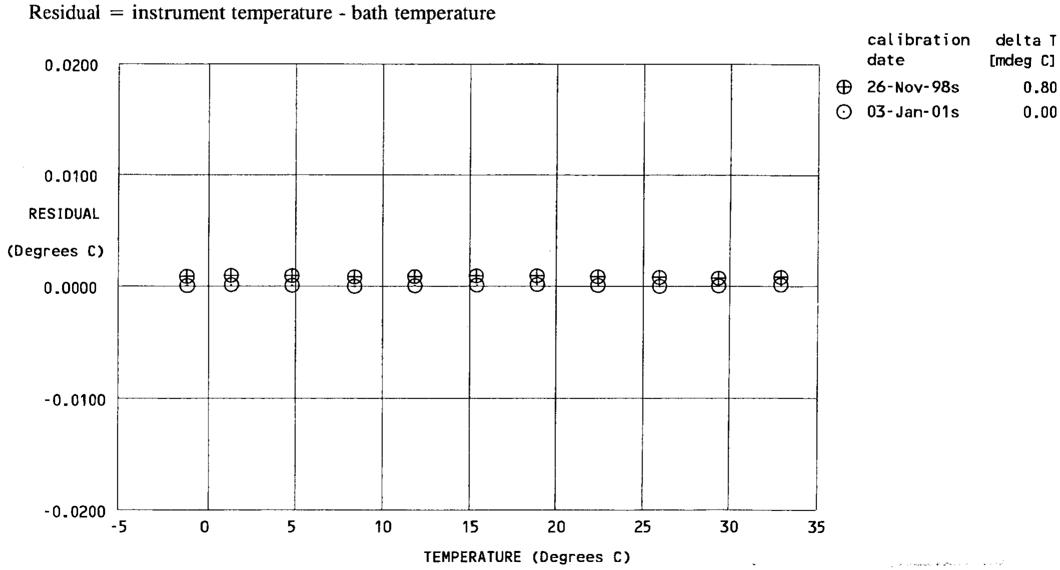
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
-1.4022	2715.661	-1.4022	-0.00002
1.1071	2877.328	1.1072	0.00005
4.5999	3113.969	4.5999	0.00001
8.1982	3372.323	8.1981	-0.00007
11.6315	3633.030	11.6314	-0.00003
15.1880	3918.156	15.1881	0.00003
18.6926	4214.514	18.6926	0.00008
22.1918	4526.070	22.1918	0.00002
25.7512	4859.455	25.7512	-0.00007
29.1661	5195.287	29.1660	-0.00004
32.6976	5559.429	32.6976	0.00005

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

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



Transmissometer

C-Star Calibration Sheet

Date:	**January 2, 2001**
Customer:	**National Science Foundation**
Serial Number:	**CST-422PR**
Job Number:	**0012016**

V_d = V dark	**0.058**
V_{air} = V out in air	**4.869**
V_{ref} = V out in H_2O	**4.765**
Calibration Temp of H_2O	**25.1**
Ambient Temperature	**25.0**

% Transmission = $(V_{sig}-V_d)/(V_{ref}-V_d)$
Tr = e^{-cx}
To solve for the attenuation coefficient c in units of m^{-1} use the following equation.
$c = -1/x\ (\ln(V_{sig}-V_d)/(V_{ref}-V_d))$
For further information on these calculations please see C Star Users Guide section I.

Temperature Error: 0.02% F.S./°C

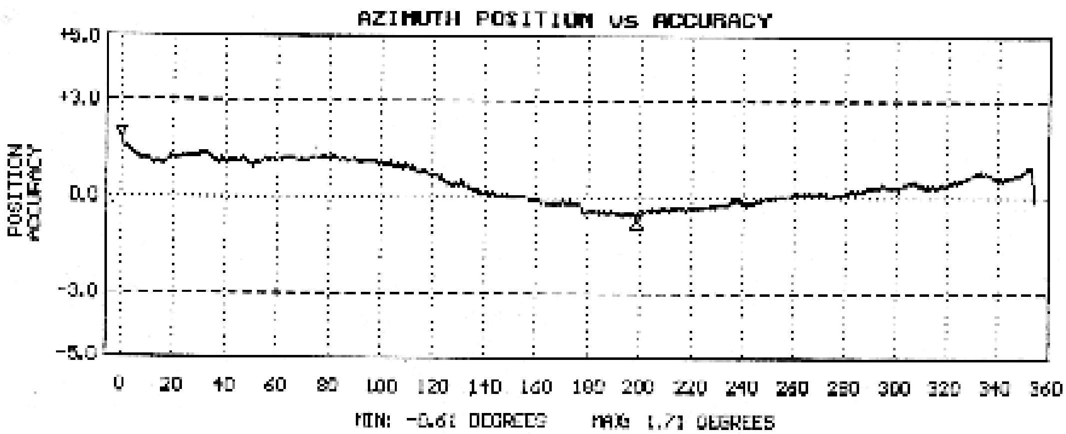
NOTES
- (V_d) is the analog output of the instrument with the beam blocked. This is an instrumental offset.
- (V_{air}) is the analog output voltage of the instrument with a cleared beam path
- (V_{ref}) is the analog output voltage of the instrument with clean H_2O in the path.
- **(Calibration Temp of H_2O)** is the temperature of the clean H_2O used to obtain V_{ref}.
- **(Ambient Temperature)** is the temperature of the instrument during the calibration procedures.
- (V_{sig}) is the measured signal voltage of the C Star.

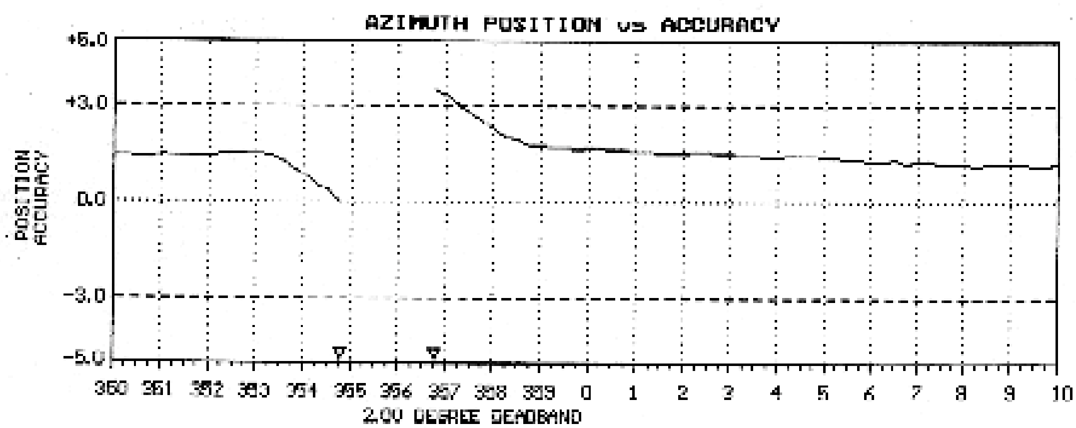
Meteorology System

Windbirds

R. M. YOUNG COMPANY WIND SENSOR CALIBRATION CERTIFICATE

SENSOR: 05106 WIND MONITOR-MA
SENSOR SERIAL NUMBER: WM46262
BEARINGS: SEALED/WATERPROOF GREASE
DATE: APR 11 2001
WIND SPEED THRESHOLD TEST: PASS
LOW WIND SPEED AMPLITUDE/FREQUENCY TEST: PASS
HIGH WIND SPEED AMPLITUDE/FREQUENCY TEST: PASS
VANE TORQUE TEST: PASS
SPECIAL NOTES:
SPECIAL NOTES:



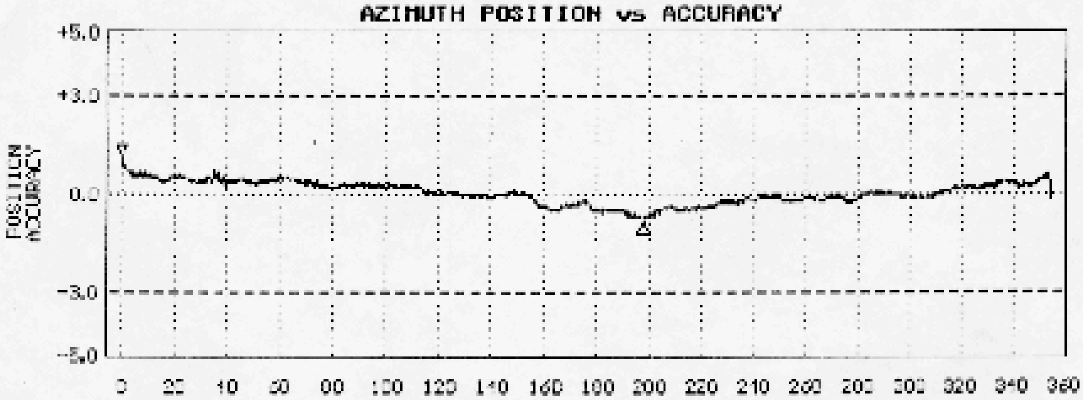


NOTE: Azimuth Position vs Accuracy graphs are accurate to within 0.5 degrees. The accuracy shown in the potentiometer deadband region between 355 and 0 degrees is the result of no resistance change while position changes. The gap represents the actual deadband (open circuit).

R. M. YOUNG COMPANY WIND SENSOR CALIBRATION CERTIFICATE

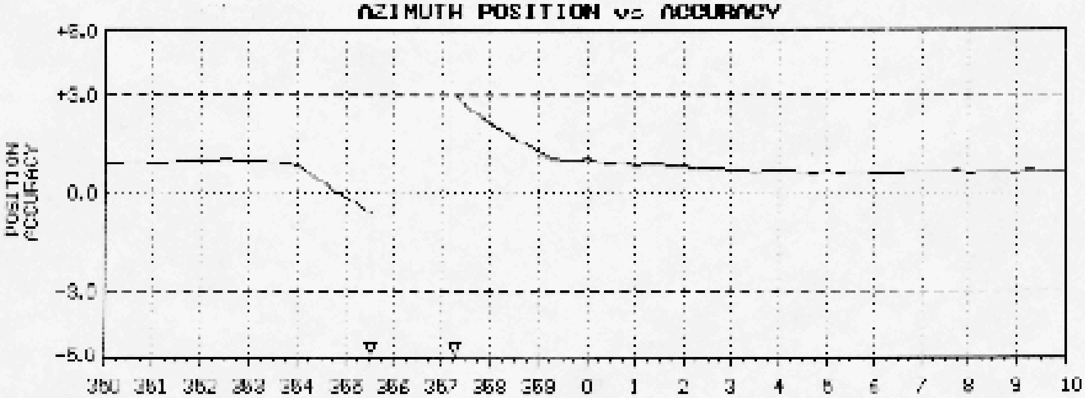
SENSOR: 05106 WIND MONITOR-MA
SENSOR SERIAL NUMBER: WM46263
BEARINGS: SEALED/WATERPROOF GREASE
DATE: APR 11 2001
WIND SPEED THRESHOLD TEST: PASS
LOW WIND SPEED AMPLITUDE/FREQUENCY TEST: PASS
HIGH WIND SPEED AMPLITUDE/FREQUENCY TEST: PASS
VANE TORQUE TEST: PASS
SPECIAL NOTES:
SPECIAL NOTES:

AZIMUTH POSITION vs ACCURACY



MIN: -0.77 DEGREES MAX: 1.07 DEGREES

AZIMUTH POSITION vs ACCURACY



1.75 DEGREE DEADBAND

NOTE: Azimuth Position vs Accuracy graphs are accurate to within 0.5 degrees. The accuracy shown in the potentiometer deadband region between 355 and 0 degrees is the result of no resistance change while position changes. The gap represents the actual deadband (open circuit).

Mast PAR

Mast PAR

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

Calibration Date	2/15/01
Model Number	QSR-240
Serial Number	6356
Operator	TPC
Standard Lamp	94532(03/13/98)
Probe Excitation Voltage Range:	5 to 18 VDC(+)
Output Polarity:	POSITIVE

Probe Conditions at Calibration(in air):

Calibration Voltage:	6	VDC(+)
Probe Current:	1.1	mA

Probe Output Voltage:

Probe Illuminated	86.6	mV
Probe Dark	0.3	mV
Probe Net Response	86.3	mV

Corrected Lamp Output:

Output In Air (same condition as calibration):

8.55E+15	quanta/cm²sec
0.014	uE/cm²sec

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

Dry:	1.01E-17	V/(quanta/cm²sec)
	6.08E+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 05/24/95

PSP

THE EPPLEY LABORATORY, INC.
12 Sheffield Ave., P.O. Box 419, Newport, RI 02840 USA
Telephone: 401-847-1020 Fax: 401-847-1031

EPLAB
Scientific Instruments for Precision Measurements Since 1917

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 33090F3

Resistance: 699 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). The adopted calibration temperature is 25 °C.

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

8.28 x 10^{-6} volts/watts meter^{-2}

5.77 millivolts/cal cm^{-2} min^{-1}

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 Eighth International Pyrheliometric Comparisons (IPC VIII) at Davos, Switzerland in October 1995.

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:
National Science Foundation
Port Heuneme, CA

Date of Test: November 7, 2000

In Charge of Test: R. T. Freeman

S.O. Number: 58282
Date: December 14, 2000

Reviewed by: Thomas D Kirk

Remarks:

PIR

THE EPPLEY LABORATORY, INC.
12 Sheffield Ave., P.O. Box 419, Newport RI 02840 USA
Telephone: 401-847-1020 Fax: 401-847-1031
Email: eplab@mail.bbsnet.com Internet: www.eppleylab.com

EPLAB
Scientific Instruments for Precision Measurements Since 1917

STANDARDIZATION OF EPPLEY PRECISION INFRARED RADIOMETER Model PIR

Serial Number: 32845F3

Resistance: 739 Ω at 23 °C
Temperature Compensation Range: 20 to 40 °C

This pyrgeometer has been compared with Precision Infrared Radiometer, Serial Number 29326F3 in Eppley's Blackbody Calibration System under radiation intensities of approximately 200 watts meter^{-2} and an average ambient temperature of 24 °C.

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

4.13 x 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.

Shipped to:
National Science Foundation
Port Hueneme, CA

S.O. Number: 58376
Date: March 1, 2001

Date of Test: February 22, 2001
In Charge of Test: R.T. Egerman
Reviewed by: Thomas D. Kirk

Remarks:

GUV

Calibration Certificate

Biospherical Instruments Inc.

Calibration Certificate for GUV & PUV Radiometers

Serial Number: 0228
Solar Calibration Dates: 06/24/01 to 06/25/01
Lamp Calibration Date: 06/21/01
Owner of Instrument: Raytheon
Data Analyst(s): JSR

Instrument Model: PUV-511A

Date Solar Data Processed: 06/26/01
Solar Reference GUV(s): 9250
Solar Ref Cal Factor Version: 1
Solar Calibration at: San Diego, CA (BSI)
General Comments: Standard Calibration

A note to the end-user. Instrument calibration is easily as important as instrument deployment, but it is often overlooked. This document has been prepared to help explain the conditions under which the different sensors in your instrument have been calibrated. Please read this information carefully and completely. If you do not understand a calibration factor, please feel free to contact the factory for a more detailed explanation.

GUV radiometers are precision, temperature-controlled filter radiometers designed for long term monitoring. PUV-510 Reference Ultraviolet Radiometers are designed to provide the above-water counterpart to the PUV-500 providing fast and accurate measurements of solar UV in the water column. Both of these series of instruments are calibrated in two different ways: "lamp calibrations" and "solar calibrations." The more familiar lamp calibration is performed in our laboratory using a NIST-traceable 1000 Watt FEL-type Standard of Spectral Irradiance and the methods described in National Bureau of Standards (US) publications 594-13 and 250-20. This standardized procedure gives good accuracy when calibrating the PAR visible channel and is useful in indicating if channel sensitivities have changed over time. Lamp calibrations are problematic for solar UV measurements because the solar spectrum is radically different from the lamp spectrum and changes greatly as a function of wavelength. Solar calibrations are achieved through direct comparison with "reference" GUVs (RGUVs) using the sun as the source of irradiance. These RGUVs are, in turn, calibrated through continuous intercomparison with a high resolution scanning spectroradiometer in San Diego (SUV-100) that is part of a world-wide UV monitoring network.

As a result of our calibration research, we have now standardized on solar calibrations for the UV channels while retaining the traditional lamp-based calibration for PAR. It is important to note that the solar calibration procedure automatically takes into account the spectral bandwidth of the detectors and therefore report the irradiance as a 1nm wide triangular bandpass centered on the nominal wavelength.

Caveats. The reference instruments used at Biospherical are "GUV" model radiometers that are temperature controlled and equipped with cosine collectors optimized for use in air. Years of GUV solar calibration experience have shown the procedure to be robust, accurate and reproducible for generalized GUV calibrations. PUVs are not temperature stabilized, a factor adding uncertainty to GUV/PUV calibration transfers. We are recommending that researchers use the solar calibration constants. Generally, these effects are well below the 10% uncertainty level. For a more detailed discussion, see Booth et al. (1994) Errors in reporting of solar irradiance using moderate bandwidth radiometers: an experimental investigation. SPIE Vol. 2258 Ocean Optics XII: 654-663.

Note: These calibration documents also apply to the "GTR" variant of the GUV instruments.

UV Irradiance Channels Calibrated Using Solar Intercomparison

ROM Tag Number	Ch#	Nominal Wavelength (nm)	Initial Offset (Volts)	Scale Factor in Air	Resulting Units
N/A	2	305	0.01655	0.93106	µW/(cm²·nm)
N/A	4	320	-0.00961	-0.14029	µW/(cm²·nm)
N/A	5	340	-0.00506	-0.11170	µW/(cm²·nm)
N/A	6	380	-0.00229	-0.05093	µW/(cm²·nm)

Note: Units for the Scale Factors are Volts/(µW/(cm^{2}·nm)). The initial offsets shown above resulted from our rooftop intercomparisons and they should be redetermined after the instrument is in its final installation, since the offset at 305nm is known to shift somewhat during shipping.

Calibration Certificate

Standard Lamp Calibrated Channels (PAR)

Serial Number: 9228

ROM Tag Number	Ch#	Nominal Wavelength (nm)	Initial Offset (Volts)	Scale Factor in Air	Resulting Units
N/A	8	PAR	0.00000	-10.8519	µE/(cm²·sec)

Lamp Reference 91773 (03/13/98) Units for the Scale Factors are Volts/(µEinsteins/(cm²·sec))

Photosynthetically Active (or Available) Radiation (PAR). In our instruments, PAR is measured over the spectral region from 400 to 700 nm using sensors with a constant quantum response (responds equally to all wavelengths). Instruments are available from Biospherical with one of two different irradiance measurement geometries. The PAR channel in the PUV measures (plane) downwelling irradiance, "Ed (PAR)", which is the downward irradiance incident on a flat surface of unit area. The measurement in a PUV-500 is made with a "cosine" collector optimized for use underwater. The GUV and PUV-510 also uses cosine collectors, but optimized for use in air. For this reason, direct comparisons of PUV-500 with PUV-510 or GUV-511 instruments are difficult.

Ed(PAR) is often confused with scalar irradiance, Eo (PAR), which is a measure of the radiance flux integrated from all directions incident on a point in space, as used by the PNF-300 Natural Fluorometer. Downweling PAR irradiance will always be less than the scalar PAR under natural aquatic conditions.

Please note that the PUV is calibrated in µE/(cm^2·sec), difference in areal unit from the PNF (cm^{-2}, not m^{-2}).

This channel is calibrated by a standard lamp.

Instrument Diagnostic Channels

ROM Tag Number	Ch#	Variable	Offset	Scale Factor	Original Value	Resulting Units
N/A	7	Ground	0	1	0.000820	Volts

Note: These channels are not normally used in data analysis, but are available for monitoring instrument performance, and for monitoring long term changes in the electronics. The offsets in these channels are normally entered with Offset as 0 and Scale as 1. Ground channels track the potential at several locations in the instrument, and the reference voltage is used to monitor the performance of the analog to digital converter. The voltages shown are not calibration factors, but they are the values at the time of this calibration and are included for reference.

Temperature

ROM Tag Number	Ch#	Function	Offset	Scale Factor	Resulting Units
N/A	1	Detector Array Temperature	0	0.01	°C
N/A	3	Electronics Temperature	0	0.01	°C

Note: "Detector Array Temperature records the temperature of the detector/filter array. It is possible to use data from this to compensate for the residual temperature sensitivity in the PUV, but this compensation is not supported in our software.

CTD

Pressure Sensor

Pressure Calibration Check 13 February 2001

pressure sensor model: Digiquartz 410K-105
sensor serial number: 43528
installed in: CTD 94857-0232

This pressure calibration is a check of the 'test' sensor against a stable reference pressure sensor. The reference pressure sensor is itself checked several times per year against a NIST-traceable pressure standard maintained at Paroscientific, Inc.. The circumstances of this pressure check introduce no more than 1.5 psia total error in 10,000 psi (0.015 %) in addition to the error resident in the Paroscientific site standard. The check offers a very high level certification of the health and proper operation of the 'test' sensor.

Input Pressure* [psia]	Sensor Output [hz]	Sensor Temperature [deg C]	Pressure Factory Coef [psia]	Pressure Corrected [psia]	Error [psia]
14.700	33289.55	21.1	17.039	15.199	0.499
2014.699	33934.55	21.2	2016.810	2014.729	0.030
4014.424	34565.78	21.2	4016.699	4014.377	-0.047
6013.899	35183.95	21.3	6016.545	6013.982	0.083
8013.376	35789.73	21.3	8016.340	8013.536	0.160
10013.005	36383.73	21.4	10015.970	10012.924	-0.081
8013.354	35789.68	21.4	8016.115	8013.310	-0.044
6013.834	35183.96	21.5	6016.481	6013.917	0.083
4014.353	34565.81	21.5	4016.592	4014.269	-0.084
2014.568	33934.47	21.5	2016.324	2014.243	-0.325
14.602	33289.35	21.6	16.168	14.328	-0.274

Input pressure is generated with a Ruska model 5201 dead-weight tester, serial number 23330/380, and is determined by measurement with reference pressure sensor model Digiquartz 410K-000, serial number 73292.

Sensor Temperature: pressure sensor internal temperature.

Pressure Corrected: pressure computed with original factory coefficients and then corrected with a slope and offset to give the best linear agreement with the 'reference' Input pressure.

Error: Corrected pressure - Input pressure

A linear fit of this calibration data, between sensor pressure computed with factory coefficients and the Input pressure, yields correction coefficients:
Corrected pressure = psi_slope * Factory pressure + psi_offset [psia]
psi_slope = 0.99988 and psi_offset = -1.84 [psia]

These are converted to Slope and Offset in decibars for use in the SEASOFT programs by: Slope = psi_slope = 0.99988
Offset = C * (psi_offset - 14.7 * (1 - psi_slope)) = -1.2684 [dbars]
C = 0.689476 [dbar/psi]

Slope and Offset coefficients are entered into the pressure sensor calibration coefficient section of the <>.CON file using the program SEACON.

Digiquartz Coefficients:

C1 = -5.102914e+04
C2 = 1.049610e-01
C3 = 1.481220e-02
D1 = 3.642300e-02
D2 = 0.000000e+00
T1 = 3.004970e+01
T2 = -3.354770e-04
T3 = 4.125600e-06
T4 = 1.811600e-09

AD590 Pressure Temperature Coefficients:

AD590M = 0.01148
AD590B = -8.78548

Calibration Correction:

Slope = 0.99988
Offset = -1.2684

Temperature Sensors

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

SENSOR SERIAL NUMBER = 2186
CALIBRATION DATE: 20-Jul-00s

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.34014822e-03
h = 6.44535956e-04
i = 2.31463347e-05
j = 2.16621304e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.67991328e-03
b = 6.02888999e-04
c = 1.62804854e-05
d = 2.16776796e-06
f_0 = 2888.568

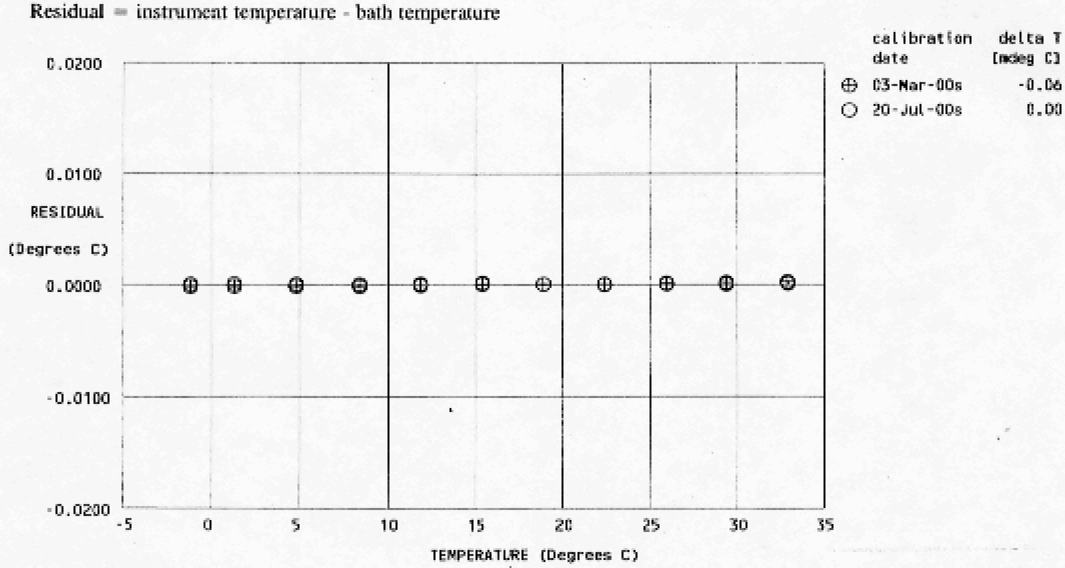
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
-1.4041	2888.568	-1.4041	0.00000
1.1035	3054.661	1.1035	0.00003
4.5980	3297.478	4.5979	-0.00005
8.1961	3561.695	8.1960	-0.00005
11.6297	3827.626	11.6297	0.00002
15.1875	4117.736	15.1876	0.00011
18.6918	4418.316	18.6918	-0.00001
22.1901	4733.397	22.1900	-0.00006
25.7512	5069.903	25.7512	0.00001
29.1658	5407.775	29.1658	-0.00002
32.6990	5773.366	32.6990	0.00003

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



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

SENSOR SERIAL NUMBER = 2168
CALIBRATION DATE: 20-Aug-99s

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.35086033e-03
h = 6.43850807e-04
i = 2.33740317e-05
j = 2.19962768e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.68002262e-03
b = 6.01206872e-04
c = 1.62750181e-05
d = 2.20118266e-06
f_0 = 2944.562

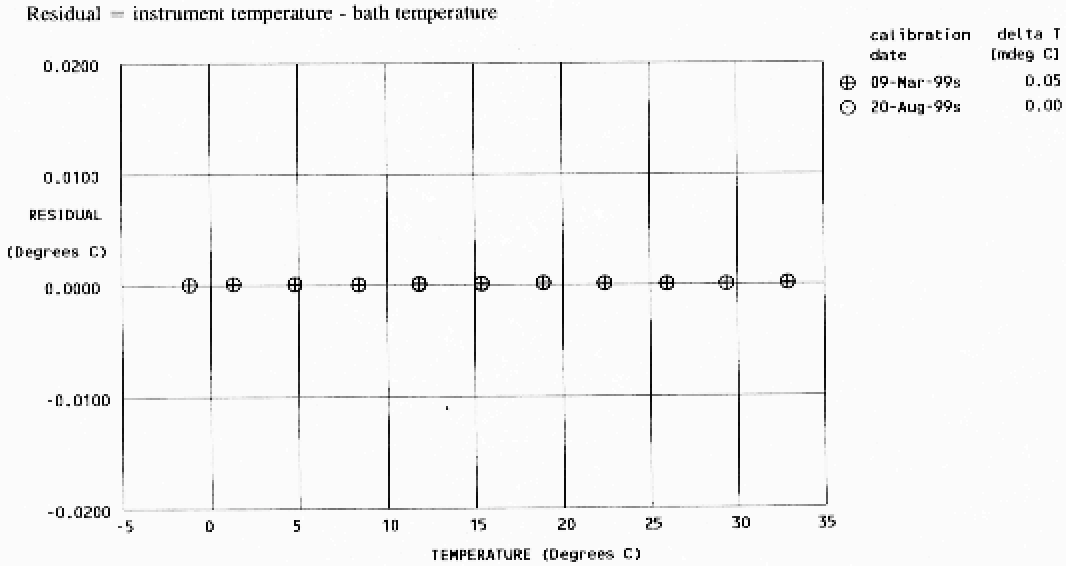
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
-1.4122	2944.562	-1.4122	-0.00003
1.0979	3114.543	1.0979	0.00005
4.5903	3362.716	4.5904	0.00001
8.1881	3632.941	8.1881	-0.00004
11.6227	3905.080	11.6227	-0.00003
15.1795	4201.868	15.1795	0.00000
18.6838	4509.533	18.6839	0.00005
22.1834	4832.222	22.1834	0.00003
25.7433	5176.658	25.7432	-0.00003
29.1586	5522.769	29.1586	-0.00004
32.6918	5897.267	32.6918	0.00003

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 Sensors

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER = 1143
CALIBRATION DATE: 19-Sep-00s

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

GHIJ COEFFICIENTS

g = -4.17368108e+00
h = 5.33200346e-01
i = -4.45561608e-05
j = 2.83534754e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

ABCDM COEFFICIENTS

a = 1.50434387e-05
b = 5.33191504e-01
c = -4.17394568e+00
d = -6.72506234e-05
m = 4.2
CPcor = -9.57e-08 (nominal)

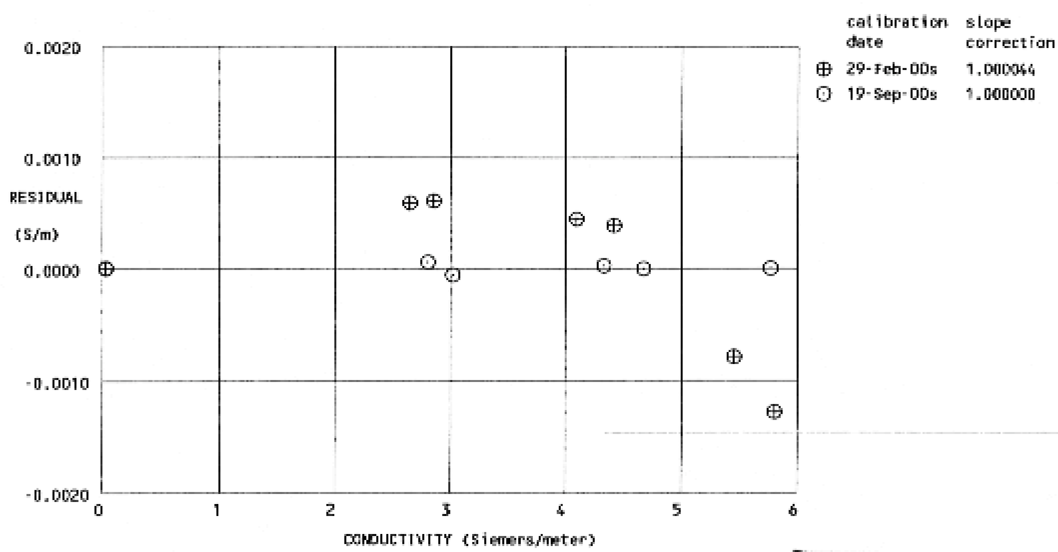
BATH TEMP (IPTS-68 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.79753	-0.00000	-0.00000
-1.3695	34.8442	2.77537	7.72841	2.77542	0.00005
1.1686	34.8527	2.99338	7.98703	2.99332	-0.00006
15.2886	34.8540	4.30369	9.39158	4.30371	0.00002
18.7267	34.8536	4.64509	9.72375	4.64508	-0.00001
29.2697	34.8489	5.73493	10.71432	5.73493	-0.00000

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

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

t = temperaure [deg C]; p = pressure [decibars]; δ = CTcor; ϵ = CPcor;

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



POST CRUISE CALIBRATION

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

SENSOR SERIAL NUMBER = 924
CALIBRATION DATE: 19-Sep-00s

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

GHIJ COEFFICIENTS

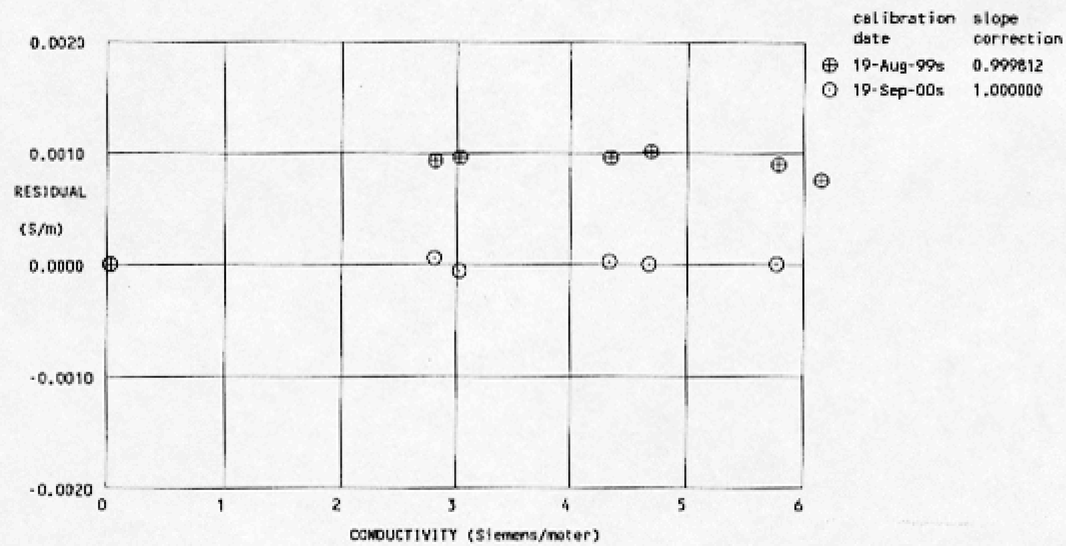
g = -4.25968885e+00
h = 5.70339194e-01
i = -7.25477890e-04
j = 6.76658032e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

ABCDM COEFFICIENTS

a = 4.57066120e-07
b = 5.67944346e-01
c = -4.25294283e+00
d = -8.86512431e-05
m = 5.6
CPcor = -9.57e-08 (nominal)

BATH TEMP (IPTS-68 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.73644	-0.00000	-0.00000
-1.3695	34.8442	2.77537	7.50283	2.77542	0.00005
1.1686	34.8527	2.99338	7.75346	2.99332	-0.00006
15.2886	34.8540	4.30369	9.11458	4.30371	0.00002
18.7267	34.8536	4.64509	9.43642	4.64508	-0.00001
29.2697	34.8489	5.73493	10.39589	5.73493	-0.00000

Conductivity = $(g + hf^2 + if^3 + jf^4) / [10(1 + \delta t + \epsilon p)]$ Siemens/meter
Conductivity = $(af^m + bf^2 + c + dt) / [10(1 + \epsilon p)]$ Siemens/meter
t = temperaure [deg C]; p = pressure [decibars]; δ = CTcor; ϵ = CPcor;
Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



POST CRUISE CALIBRATION

Dissolved Oxygen Sensor

Sea-Bird Electronics, Inc. FAX: (425) 643-9954
1808 136th Place NE, Bellevue, Washington 98005 USA Tel:(425)643-9866
Website: http://www.seabird.com Email: seabird@seabird.com

DISSOLVED OXYGEN SENSOR CALIBRATION: S/N 130295 21 July 2000

Sensor type:

Beckman, Module S/N 7-04-05

Sensor Current

m = 2.4619 E-7
b = -3.9390 E-10

The use of these constants in a linear equation of the form

$I = mV + b$

will yield DO sensor membrane current as a function of sensor output voltage.

Sensor Compensation Temperature

k = 8.9729
c = -6.8765

The use of these constants in a linear equation of the form

$T = kV + c$

will yield membrane temperature as a function of temperature channel voltage with a maximum error of about 0.5 deg C. The correction to dissolved oxygen resulting from the use of this calibration should be sufficient to achieve the precision of which the sensor is capable.

SEASOFT Coefficients based on Oxfit Calibration Results

Soc	2.4241	
Boc	-0.0259	
tcor	-0.033	(nominal)
pcor	1.50e-4	(nominal)
tau	2.0	(for profiling applications only)
tau	0.0	(for moored applications only)
wt	0.67	(for Beckman type sensors)
wt	0.85	(for YSI type sensors)

barometer	=	1007.241	mB
Twater	=	5.756	deg C
Tcomp	=	5.398	deg C
Isat	=	0.506	uA
Iair	=	0.662	uA
Izero	=	0.010	uA

Fluorometer

CERTIFICATE OF CALIBRATION

Date of issue 16th July 2001

Description Mk III Aquatracka (Chlorophyll-a)

Serial Number 088080

REPORT

The fluorimeter was exposed to various concentrations of Chlorophyll-a dissolved in acetone in addition to pure water and pure acetone. The following formula was derived from the readings to relate instrument output to chlorophyll-a concentration.

$$\text{Conc.} = (0.0136 \times 10^{\text{Output}}) - 0.0207$$

Where:-

conc. = fluorophor concentration in μg/l
Output = Aquatracka output in volts

The above formula can be used in the range 0 - 100 microgrammes per litre to an uncertainty of 0.02 microgrammes per litre plus 8% of value.

Notes

The above formula has been derived using Chlorophyll-a dissolved in acetone. No guarantee is given as to the performance of the instrument to biologically active chlorophyll in sea-water.

The zero offset has been determined in the laboratory using purified water from a reverse osmosis/ion exchange column. It is possible that purer water may be found in clean deep ocean conditions. Under these conditions, the offset shown in the above formula should be replaced by the antilogarithm of the Aquatracka output in the purest water found, multiplied by the scale factor.

Serial number 088080 Page 1 of 2

Fluorimeter calibration readings

Ambient temperature 20°C

Output for detector mechanically blanked 0.0017 Volts —

Output for pure water 0.1827 Volts

chlorophyll concentration in acetone (μg/l)	Output (volts)
Acetone (pure)	0.2420 —
0.1	1.0312
0.3	1.3904
1.0	1.8651 —
2.99	2.3625
9.9	2.8613
29.1	3.3114
90.9	3.7852

The uncertainty of the chlorophyll concentration is estimated not to exceed 3%. The uncertainty of output voltage measurement is estimated not to exceed 2mV.

Signed [signature] Date 16/7/01

Serial number 088080 Page 2 of 2

CTD PAR

UNDERWATER PAR SENSOR WITH LOG AMPLIFIER

Calibration Date: 06/27/01 **Job No.:** R7748
Model Number: QSP200L
Serial Number: 4351
Operator: TPC
Standard Lamp: 94532 (03/13/98)
Operating Voltage Range: 6 to 15 VDC (+)

Note: The QSP-200L 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:	**1.64E+12**	**quanta/cm² sec/"amps"**	**2.72E-06**	**µEinsteins/cm² sec/"amps"**
Wet Calibration Factor:	**2.76E+12**	**quanta/cm² sec/"amps"**	**4.58E-06**	**µEinsteins/cm² sec/"amps"**

Sensor Test Data and Results[4)]

Sensor Supply Current (Dark):	76.5	mA			
Supply Voltage:	6	Volts			
Lamp Integrated PAR Irradiance:	8.55E+15	quanta/cm² sec	0.01420	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/ cm² sec)
No Filter	100.00%	3.718	100.00%		5.22E-07	5.22E-07	3.718	0.000	0.0	8.55E+15
0.3	36.10%	3.272	35.79%		1.87E-07	1.89E-07	3.276	0.004	0.9	3.06E+15
0.5	27.60%	3.161	27.71%		1.45E-07	1.44E-07	3.159	-0.002	-0.4	2.37E+15
1	9.27%	2.698	9.52%		4.97E-08	4.84E-08	2.686	-0.012	-2.7	8.15E+14
2	1.11%	1.798	1.17%		6.13E-09	5.80E-09	1.775	-0.023	-5.4	1.00E+14
3	0.05%	0.760	0.08%		4.22E-10	2.79E-10	0.636	-0.124	-34.0	6.92E+12

Dark Before:	0.185	Volts			
Light - No Filter Hldr.:	3.719	Volts	I_{Ref} =	1.00E-10	Amps
Dark After - NFH:	0.185	Volts	I_{Dark} =	1.53E-10	Amps
Average Dark	0.185	Volts	10^{VDark} =	1.531087	Amps

Calibration constant = $\frac{10^5}{\text{Wet.Cal.Fact}} = \frac{10^5}{4.58 \times 10^{-6}}$
$= 2.18 \cdot 10^{10}$

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 4099.xls

CTD Transmissometer

25 cm TRANSMISSOMETER OPERATING INSTRUCTIONS

OPERATION & CALIBRATION:

First, connect a power source (9 to 30 VDC) to the instrument as shown on the connector wiring diagram, see figure 1. Observe polarity when connecting the power supply to the transmissometer, connect positive to pin 4 and negative to pin 1.

Use a voltmeter to measure the output voltage, pin 2 is the output and pin 3 is ground.

Block the light path to measure the zero output, it should be 0.00, +/- .01 VDC.

Clean the windows using kimwipes (or other non abrasive material), with a solution of dish washing liquid and water. When the windows are clean, the output voltage in air should be within +/- .02 VDC of the AIR CALIBRATION value listed below.

Perform the above procedure before each calibration and use of the instrument to measure transmission of water. The wavelength of the source is 660 nm, and at this wavelength the maximum value for light transmission in clean water with a 25 cm path length is 91.3% (4.565 VDC). Pure water absorption is 8.7% for a 25 cm path length at 660 nm.

MOUNTING INSTRUCTIONS:

A mounting bracket is provided with the transmissometer to simplify mounting the instrument on your system, see figure 2.

PRECAUTIONS:

DO NOT OPEN THE INSTRUMENT--this voids the warranty. If the instrument does not function properly, please consult the factory.

DO NOT LEAVE THE INSTRUMENT ON WHEN NOT IN USE. The LED is quite stable, but it will decrease in intensity, like most light sources, if left on for a long period of time.

DATA REDUCTION:

Air calibration may change with time. The LED light output can decrease approximately 1% in 1000 hours of operation. If the air calibration is measured frequently and the following correction is applied, then this change can be compensated for and will not affect the accuracy of the data.

$$V=(A/B) \cdot (X-Z) \quad \text{and} \quad \%\ \text{Transmission} = 20 \cdot V$$

V=Corrected output voltage, (≤ 4.565 VDC since 91.3% is pure water).
A=Air calibration value listed below.
B=Air calibration (present value).
X=Data value (output voltage measured in water).
Z=Zero offset with light path blocked.

The AIR CALIBRATION for SN- 207D was 4.650 VDC on 6/21/2001 .

The ZERO OFFSET with the light path blocked is -0.001 VDC

10 m² MOCNESS

Pressure Sensor

DEPTH SENSOR CALIBRATION
February 24, 2001

The pressure sensor used in the MOCNESS is a titanium strain gauge with an internal temperature sensor. The temperature of the sensor is measured and used to correct for the thermal offsets in the measurement of pressure. The MOCNESS measures the voltage across the pressure and temperature bridges of the sensor and reports these values in its output data stream. The MOCNESS pressure sensor is calibrated at several pressure points and at two temperatures. There are no adjustments in the MOCNESS hardware and all calibration is done in software in the surface control computer. The values sent up the wire in the MOCNESS data stream (the bridge voltages) are scaled to be sent as integers in the range of 0-99999 for pressure and 0-9999 for temperature. The calibration data is fit by the following equation-

Z=(C1*Vt+C0)*Vp^2+(B1*Vt+B0)*Vp+(A1*Vt+A0)

where-
Z=pressure in decibars (1 decibar is approx 1m of water)
Vp=voltage reading in data stream from pressure sensor
Vt=voltage reading in data stream from temperature sensor

The following constants are for your MOCNESS underwater unit.

serial_number =
149
C1 =
1.346556023582793e-13
C0 =
-9.659981195534541e-10
B1 =
-4.746135708603977e-08
B0 =
0.10487288807002
A1 =
0.00155922569240
A0 =
-1.728933890313200e+02

Temperature Sensor

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

SENSOR SERIAL NUMBER = 2308
CALIBRATION DATE: 13-Feb-01s

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.34511387e-03
h = 6.44649603e-04
i = 2.32791524e-05
j = 2.17789379e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.67988438e-03
b = 6.02488784e-04
c = 1.63217829e-05
d = 2.17945242e-06
f_0 = 2912.686

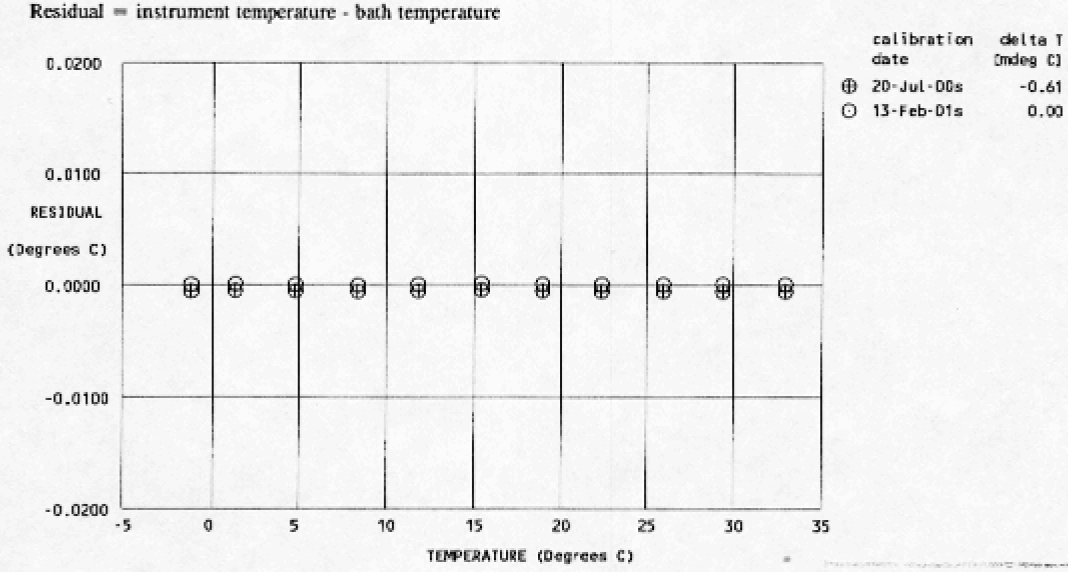
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
-1.4020	2912.686	-1.4020	-0.00002
1.1064	3080.329	1.1064	0.00004
4.5997	3325.277	4.5997	0.00001
8.1974	3591.873	8.1973	-0.00007
11.6315	3860.289	11.6315	-0.00001
15.1885	4153.028	15.1886	0.00008
18.6926	4456.395	18.6926	0.00001
22.1918	4774.526	22.1918	-0.00003
25.7525	5114.166	25.7525	-0.00002
29.1672	5455.263	29.1672	-0.00001
32.7000	5824.319	32.7000	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



Conductivity Sensor

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = [redacted]
CALIBRATION DATE: [redacted]

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

GHIJ COEFFICIENTS

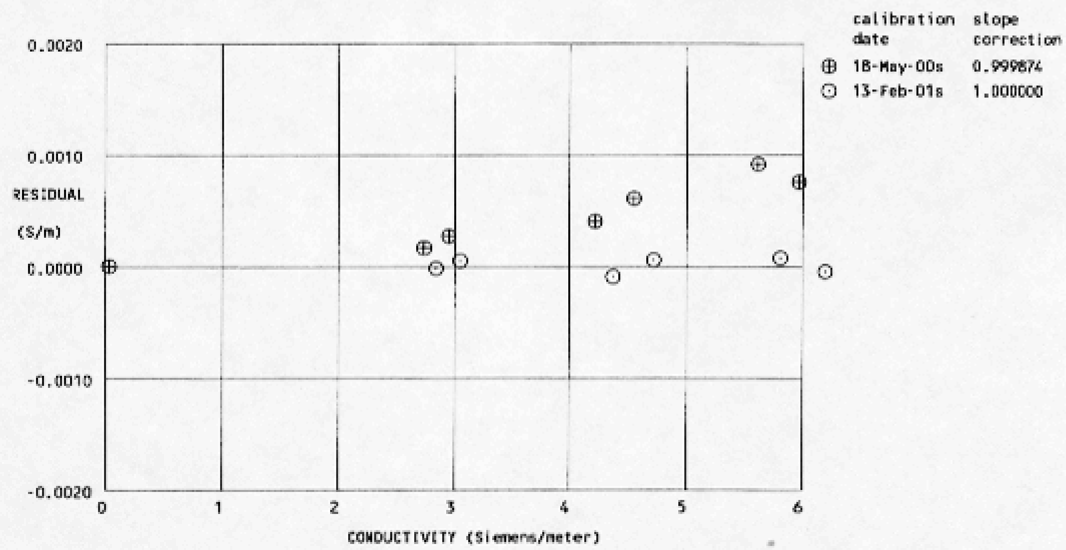
g = -4.01117657e+00
h = 5.12546273e-01
i = -6.99560953e-04
j = 6.25815267e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

ABCDM COEFFICIENTS

a = 8.39979738e-07
b = 5.10029980e-01
c = -4.00275995e+00
d = -7.97220076e-05
m = 5.3
CPcor = -9.57e-08 (nominal)

BATH TEMP (IPTS-68 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.80151	-0.00000	-0.00000
-1.4420	35.3110	2.80288	7.91886	2.80286	-0.00002
1.0175	35.3098	3.01560	8.17699	3.01565	0.00005
15.1713	35.3104	4.34237	9.62905	4.34227	-0.00010
18.6473	35.3086	4.69106	9.97512	4.69111	0.00005
29.0551	35.3072	5.77876	10.98252	5.77883	0.00007
32.6126	35.3025	6.16250	11.31576	6.16245	-0.00005

Conductivity = $(g + hf^2 + if^3 + jf^4) / [10(1 + \delta t + \epsilon p)]$ Siemens/meter
Conductivity = $(af^m + bf^2 + c + dt) / [10(1 + \epsilon p)]$ Siemens/meter
t = temperaure [deg C]; p = pressure [decibars]; δ = CTcor; ϵ = CPcor;
Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



1 m^2 MOCNESS

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February 24, 2001

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Z=(C1*Vt+C0)*Vp^2+(B1*Vt+B0)*Vp+(A1*Vt+A0)

where-

Z=pressure in decibars (1 decibar is approx 1m of water)
Vp=voltage reading in data stream from pressure sensor
Vt=voltage reading in data stream from temperature sensor

The following constants are for your MOCNESS underwater unit.

serial_number =
[redacted]
C1 =
2.037514784245094e-13
C0 =
-1.160376389332701e-09
B1 =
-4.224964637147011e-08
B0 =
0.10472170489350
A1 =
-9.167471452965571e-04
A0 =
-1.856354586415713e+02

Temperature Sensor

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

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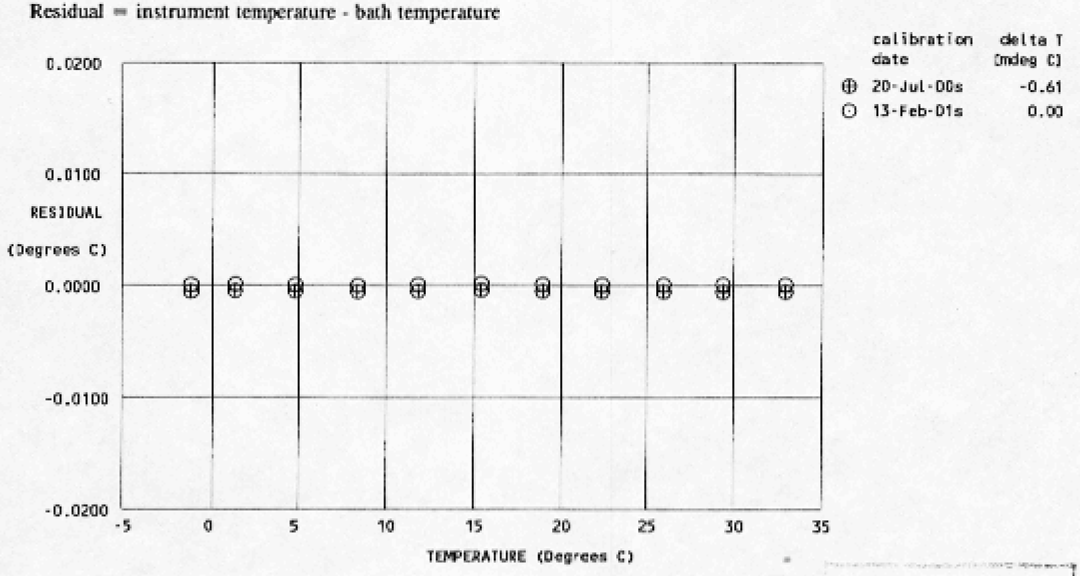
Temperature IPTS-68 $= 1/\{a + b[\ln(f_0/f)] + c[\ln^2(f_0/f)] + d[\ln^3(f_0/f)]\} - 273.15$ (°C)

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 Internet: seabird@seabird.com

SENSOR SERIAL NUMBER = [redacted]
CALIBRATION DATE: [redacted]

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

GHIJ COEFFICIENTS

g = -4.01117657e+00
h = 5.12546273e-01
i = -6.99560953e-04
j = 6.25815267e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

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c = -4.00275995e+00
d = -7.97220076e-05
m = 5.3
CPcor = -9.57e-08 (nominal)

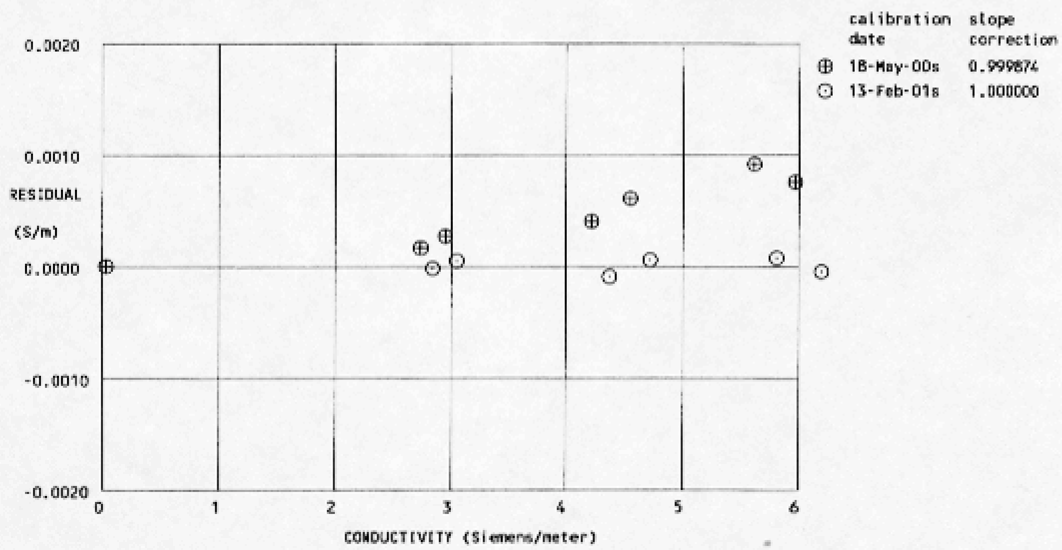
BATH TEMP (IPTS-68 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.80151	-0.00000	-0.00000
-1.4420	35.3110	2.80288	7.91886	2.80286	-0.00002
1.0175	35.3098	3.01560	8.17699	3.01565	0.00005
15.1713	35.3104	4.34237	9.62905	4.34227	-0.00010
18.6473	35.3086	4.69106	9.97512	4.69111	0.00005
29.0551	35.3072	5.77876	10.98252	5.77883	0.00007
32.6126	35.3025	6.16250	11.31576	6.16245	-0.00005

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

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

t = temperaure [deg C]; p = pressure [decibars]; δ = CTcor; ϵ = CPcor;

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



Transmissometer

PO Box 518
620 Applegate St.
Philomath OR 97370

WET Labs

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

C-Star Calibration Sheet

Date: [redacted]
Customer: BESS
Serial Number: [redacted]
Job Number: 0102007
Work Order: 01A

V_d = V dark	**0.059**
V_{air} = V out in air	**4.827**
V_{ref} = V out in water	**4.737**
Calibration Temperature of water	**25.6**
Ambient Temperature	**25.7**

% Transmission = $(V_{sig}-V_d)/(V_{ref}-V_d)$
$Tr = e^{-cx}$
To solve for the attenuation coefficient **c** in units of $\mathbf{m^{-1}}$ use the following equation.
$c = -1/x\ (\ln(V_{sig}-V_d)/(V_{ref}-V_d))$
For further information on these calculations please see C-Star User's Guide, Section 2.

Temperature Error: 0.02% F.S./°C

NOTES

- **(V_d)**—analog output of the instrument with the beam blocked. This is an instrumental offset.
- **(V_{air})**—analog output voltage of the instrument with a cleared beam path.
- **(V_{ref})**—analog output voltage of the instrument with clean H_2O in the path.
- **(Calibration Temperature of water)**—temperature of the clean water used to obtain V_{ref}.
- **(Ambient Temperature)**—temperature of the instrument during the calibration procedures.
- **(V_{sig})**—measured signal voltage of the C-Star.

Fluorometer

Chlorophyll Fluorometer Calibration

Date: 2/21/01
Serial # AFLD016
Tester Christian

Test Description

1. Dissolved chlorophyll fluorescence (fresh spinach tea) is measured against spectrophotometric readings for given concentrations
2. Chlorophyll concentration is determinied by CHL = achl/a*
   where CHL is concentration in ug/l
   achl is absorption due to chlorophyll a676 - (a650+a715)/2 as perscribed by Zaneveld
   a* is estimated chlorophyll absorption
3. Sensitivity T is calculated by T = CHL/Volts
   where T is sensitivity factor in ug/l Volts
   V is value in volts
4. Resolution is calculated by taking the noise in Volts /T
5. Range is calculated by Maximum No of Volts * T

NOTE: To Calculate ug/l chlorophhyl fluorescence from Voltage:

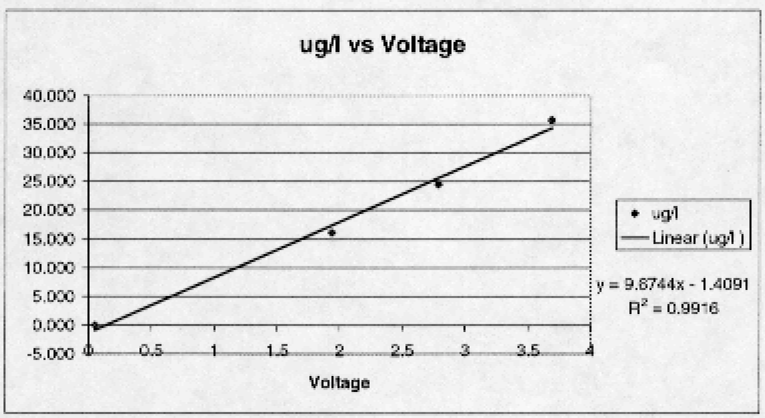
Fchl = SF *(Measured Voltage - CWO)
Fchl = 9.674 *(Measured Voltage - 0.0520)

Stdev 0.000983192
a* 0.02
BG = Background Concentration
SF = Scale Factor
CWO = Clean Water Offset

Chlorophyll Absoprtion Calculations

Rel Conc	a650	A676	A715
0 (BG)	0.113	0.109	0.108
1	0.396	0.631	0.223
2	0.496	0.854	0.231
3	0.666	1.187	0.270

Rel Conc	achl	Abs est Conc µg/l	Volts+BG V+BG	Voltage Voltage	*Sensitivity* (Scale Factor)	Resolution	Range
0 (BG)	-0.001	-0.025	0.052	0.000	µg/l/V	µg/l	µg/l
1.00	0.322	16.075	1.94	1.888	**9.674**	**0.010**	**48.372**
2.00	0.491	24.525	2.791	2.739			
3.00	0.715	35.750	3.689	3.637			



Optical Plankton Counter

APPENDIX E - SYSTEM INFORMATION

Model: **OPC-1T Optical Plankton Counter**
Serial #: **TOW031**
Max. Depth: **Housing 1000 m, Depth Sensor 660 m**
Housing: 6061-T6 Aluminum, PVC
Mass: 19 kg (including sensors)
Firmware: 216-1004-00 A
Software: 216-0403-02 F

OPTIONS

OPC Power: OPC Power Connector: Impulse XSG-2-BCL
Modifications to OPC Power Plate Wiring (216-0239-00)
ASA OPC-1T Test Cable (216-0236-00)

Depth Sensor: Omega PX603-1KG5V Pressure Transducer
0 - 1000 psi, Sealed Gauge; 1 - 5 VDC Output
S/N 60301482
Modifications to OPC Power/Data PCB (Schematic 216-0220-05)

Flow Sensor: General Oceanics Model GO2031H Electronic Flow Meter
Standard Rotor (0.1 - 7.9 m/s range)
S/N B15198
Modifications to OPC Power/Data PCB (Schematic 216-0228-00)
Modifications to GO2031 Harness (Schematic 216-0232-00)

Interface for Wetlabs WETStar Fluorometer:
Modifications to OPC Power/Data PCB (Schematic 216-0224-00)
OPC-WETStar Jumper Cable (Schematic 216-0237-00)

Interface for Seabird SBE19:
Modifications to OPC Power/Data PCB (Schematic 216-0238-00)
OPC-SBE19 Jumper Cable (Schematic 216-0227-00)

OPC BEAD CALIBRATION (Average of 10 trials, Nylon beads)

Bead Diameter (mm)	Measured Diameter (mm)	Error
1.588	1.634	+3%
2.381	2.430	+2%
3.175	3.048	-4%

System configuration specifications supercede those listed on data sheets. Subsequent OPC modifications may void the above information.

August 1, 1996

— SEE BACK OF PAGE FOR ADDITIONAL INFO —