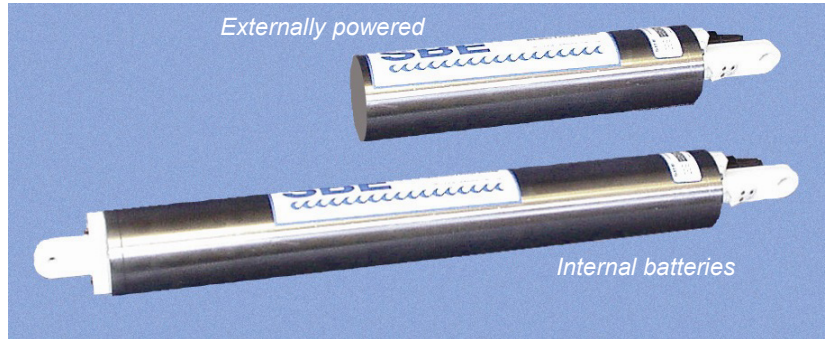


SBE 54 Tsunameter



User's Manual

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Manual Version #007, 05/20/13
Firmware Version 1.3 and later
SeatermV2 Version 2.2.6c and later



Limited Liability Statement

Extreme care should be exercised when using or servicing this equipment. It should be used or serviced only by personnel with knowledge of and training in the use and maintenance of oceanographic electronic equipment.

SEA-BIRD ELECTRONICS, INC. disclaims all product liability risks arising from the use or servicing of this system. SEA-BIRD ELECTRONICS, INC. has no way of controlling the use of this equipment or of choosing the personnel to operate it, and therefore cannot take steps to comply with laws pertaining to product liability, including laws which impose a duty to warn the user of any dangers involved in operating this equipment. Therefore, acceptance of this system by the customer shall be conclusively deemed to include a covenant by the customer to defend, indemnify, and hold SEA-BIRD ELECTRONICS, INC. harmless from all product liability claims arising from the use or servicing of this system.

Declaration of Conformity

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005 USA

DECLARATION OF CONFORMITY

Manufacturer's Name: Sea-Bird Electronics
Manufacturer's Address: 13431 NE 20th Street
Bellevue, WA 98005, USA

The Authorized Representative located within the Community is:
OTT MESSTECHNIK GmbH & Co.KG
P.O.Box: 2140 / 87411 Kempten / Germany
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Device Description: Various Data Acquisition Devices and Sensors

Model Numbers:

3S	3F	3plus	4C	4M	5T	5P	5M	7
8	9plus	11plus	14	16plus V2	16plus-IM V2		17plus V2	18
19plus V2	21	25plus	26plus	27	29	32	32C	32SC
33	35	35RT	36	37-IMP	37-IM	37-SMP	37-SM	37-SIP
37-SI	38	39	39-IM	41	41CP	43	43F	44
45	49	50	52-MP	53BPR	54	55	56	63
SIM	ICC	IMM	PDIM	AFM	90488	90204	90402	90504
Glider Payload CTD		NiMH Battery Charger and Battery Pack						

Applicable EU Directives: Machinery Directive 98 / 37 /EC
EMC Directive 2004 / 108 /EC
Low Voltage Directive (73 / 23 /EEC) as amended by (93 / 68 /EEC)

Applicable Harmonized Standards:
EN 61326-1:2006 Class A Electrical Equipment for Measurement, Control, and Laboratory Use, EMC Requirement – Part 1: General Requirements
(EN 55011:2007 Group 1, Class A)

EN 61010-1:2001, Safety Requirements for Electrical Equipments for Measurement, Control, and Laboratory Use – Part 1: General Requirements

Declaration based upon compliance to the Essential Requirements and Letter of Opinion from CKC Certification Services, LLC., Notified Body 0976

I, the undersigned, hereby declare that the equipment specified above conforms to the above European Union Directives and Standards.

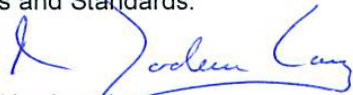
Authorized Signature: 
Name: Nordeen Larson
Title of Signatory: President
Date: 27 June 2012
Place: Bellevue, WA

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Section 1: Introduction

This section includes a Quick Start procedure, and photos of a standard SBE 54.

About this Manual

This manual is for use with the SBE 54 Tsunameter. It is organized to guide the user from installation through operation, data collection, and processing. We have included detailed specifications, command descriptions, maintenance and calibration information, and helpful notes throughout the manual.

Sea-Bird welcomes suggestions for new features and enhancements of our products and/or documentation. Please contact us with any comments or suggestions (seabird@seabird.com or 425-643-9866). Our business hours are Monday through Friday, 0800 to 1700 Pacific Standard Time (1600 to 0100 Universal Time) in winter and 0800 to 1700 Pacific Daylight Time (1500 to 0000 Universal Time) the rest of the year.

Quick Start

Follow these steps to get a Quick Start using the SBE 54. The manual provides step-by-step details for performing each task.

Deployment:

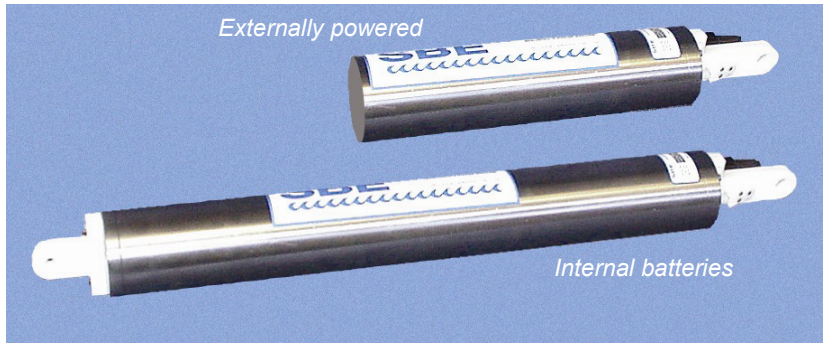
1. Install new batteries.
2. Connect SBE 54 to computer and run SeatermV2 (*Section 3*):
 - A. Ensure all data has been uploaded, and then send **InitLogging** to make entire memory available for recording if desired.
 - B. Set date and time (**SetTime=**) and sampling period (**SetSamplePeriod=**).
 - C. Check configuration (**GetCD**) and status (**GetSD**).
 - D. Start logging (**Start**).

Recovery and Data Processing:

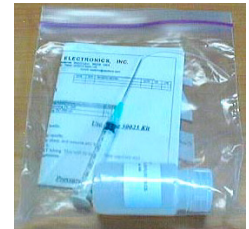
1. Connect SBE 54 to computer and run SeatermV2. Stop logging (**Stop**), and upload data from SBE 54 memory (*Section 3*).

Unpacking SBE 54

Shown below is a typical SBE 54 shipment.



I/O cable



Pressure sensor oil refill kit



Spare hardware kit



Jackscrew kit



(for SBE 54 with internal batteries)
Spare battery end cap hardware and o-ring kit



(battery cover plates for SBE 54 with internal batteries)
801575 – for use with lithium DD batteries
41124B – for use with alkaline D batteries



Software, and electronic copy of user manual

Section 2: Description of SBE 54

This section describes the functions and features of the SBE 54, including specifications, dimensions, end cap connector, power supply information, cable length limitations, data I/O protocols, and real-time setup.

System Description

Reliable detection of deep ocean tsunami waves without generating false alarms requires a sensor that can accurately detect pressure changes of millimeter scale while sampling rapidly enough to characterize the shape of the tsunami waves and reflections in real-time.

In addition to having extremely high resolution, the acquisition circuitry must be low power and be free of noise, drift, and temperature-induced changes. The pressure sensor must be reliable, stable, and capable of generating high resolution outputs.

Sea-Bird's tsunami sensor continuously measures and outputs pressure at user-programmable periods. Pressure resolution is better than 0.11 mm at full ocean depth (7000 meters), at the default sample period of 15 seconds. The tsunami sensor's sole purpose is to function as the heart of a deep ocean tsunami detection system. Setup and operation require no user interaction. A power supply supervisor and watchdog timer ensure automatic recovery if power or normal operation is interrupted.

The SBE 54 Tsunameter combines a Paroscientific Digiquartz[®] pressure transducer, microcontroller, real-time clock with temperature-compensated crystal oscillator, precision temperature-compensated reference frequency, three high-resolution frequency acquisition circuits, EEPROM, and FLASH memory. The reference frequency used to acquire the pressure and pressure temperature outputs from the Digiquartz pressure sensor is accurate to one part per million and stable to 0.1 parts per million. The pressure sensor, reference frequency, and acquisition circuits are powered continuously to eliminate errors caused by start-up transients. Pressure and pressure temperature are acquired simultaneously to eliminate phasing errors and increase the measurement resolution in each channel.

The Digiquartz pressure sensor performance degrades in the presence of thermal gradients. To minimize gradients, the SBE 54 thermally isolates the pressure sensor from both the housing and the rest of the electronics. The SBE 54 can output the temperature of the pressure sensor. This output allows estimation of the probability of pressure noise due to dynamic temperature effects.

The SBE 54 allows a user-input sample period from 1 to 240 seconds. The resolution of the pressure measurement depends on the sample period. Larger sample periods provide better resolution.

$$\text{Resolution (in \% of full scale)} = 0.001 / 6T$$

where T is the sample period in seconds

The default 15-second sample period provides resolution of $1.1 \times 10^{-5} \%$, which is 0.11 parts per million. This corresponds to 0.8 mm water depth with a 10,000 psi sensor. The SBE 54 achieves this resolution with extremely low-power electronics – most of the instrument's power is consumed by the pressure sensor.

Low power consumption (0.015 Watts at 15V) makes multi-year, battery-powered deployments practical. The 128 Mbyte FLASH memory can store up to 8.9 million samples, providing more than four years continuous backup of the entire raw pressure record at the default 15-second sample period.

Preserving the entire time series in memory allows a post-deployment engineering review of the instrument's performance, as well as a scientific analysis of the entire deployment record. The EEPROM stores calibration coefficients and diagnostic information. The Digiquartz pressure sensor and the frequency reference are tested and re-characterized at Sea-Bird to meet the demanding millimeter-scale sensitivity requirements.

The SBE 54 is self-contained in a rugged, non-corroding, titanium housing for depths to 7000 meters. After recovery (and without opening the housing), the recorded data is transferred to a computer via an RS-232C data link for analysis, plotting, and permanent archiving. The optional battery compartment contains twelve standard alkaline D-cells (Duracell MN1300, LR20) or six Electrochem lithium DD-cells, and is sealed separately to minimize risk to the electronics.

The standard SBE 54 includes:

- Titanium housing (short, no battery compartment, externally powered) for depths to 7000 meters (22,900 ft)
- 6800 meter (10,000 psia) Paroscientific Digiquartz temperature-compensated pressure sensor
- 128 MB FLASH memory
- RS-232 interface
- Impulse glass-reinforced epoxy bulkhead connector

SBE 54 options include:

- 1300, 2000, or 4000 meter (2000, 3000, or 6000 psia) Paroscientific Digiquartz temperature-compensated pressure sensor
- Long housing with battery compartment for 12 alkaline D-cell batteries (Duracell MN1300, LR20) or 6 DD lithium cells with buttons; internal battery is diode or-ed with external supply for use as backup to external power supply. Note that lithium batteries are **not** supplied by Sea-Bird. One lithium DD battery is shorter than two alkaline D batteries, so a different battery cover plate is required if using the lithiums (cover plate available from Sea-Bird)
- Wet-pluggable (MCBH) bulkhead connector in place of standard connector

The SBE 54 is supplied with a powerful Windows program, Seasoft V2, which includes:

- **SeatermV2** – terminal program for easy communication and data retrieval. SeatermV2 is a *launcher*. Depending on the instrument selected it launches **Seaterm232** (RS-232 instruments, such as this SBE 54), **Seaterm485** (RS-485 instruments), or **SeatermIM** (inductive modem instruments).

Notes:

- Help files provide detailed information on SeatermV2.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our FTP site. See our website (www.seabird.com) for the latest software version number, a description of the software changes, and instructions for downloading the software from the FTP site.

Specifications

Note:

The pressure sensor is mounted on the titanium connector end cap, with the pressure conveyed from the pressure port to the sensor via an oil-filled tube. The pressure reading is position sensitive as a result of the oil pressure head.

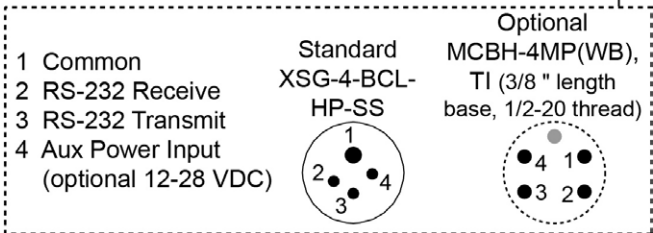
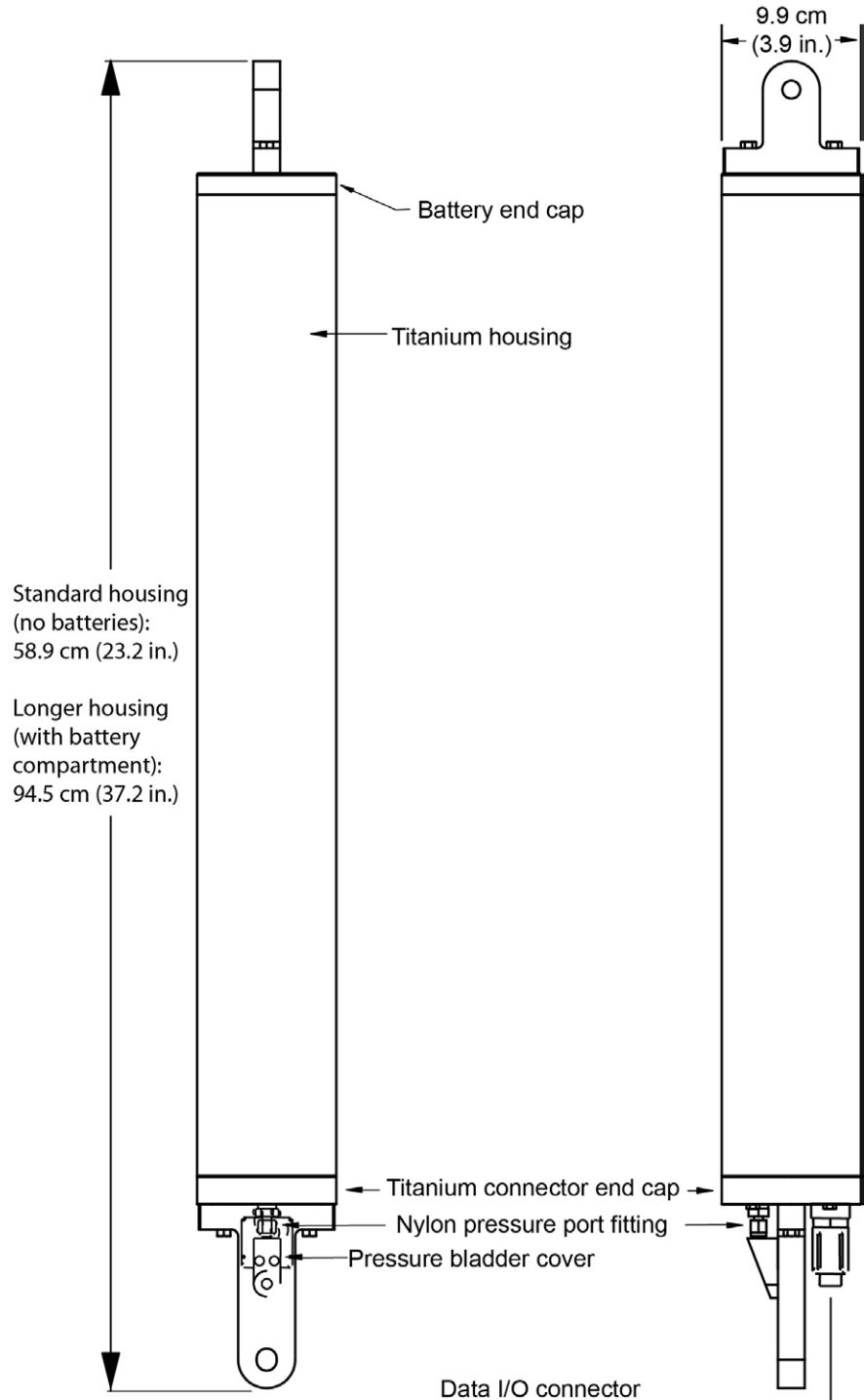
Pressure	
Output	Pressure in ASCII engineering units (psia and/or dbar) at user-input sample periods (1 – 240 sec sample period; default 15 sec)
Range	<i>Standard:</i> 0 to 6800 m (10000 psia) <i>Optional:</i> 0 to 1300, 2000, or 4000 m (2000, 3000, or 6000 psia)
Accuracy *	0.01% of full scale
Repeatability	0.005% of full scale
Hysteresis	0.005% of full scale
Calibration	0 psia to full scale pressure
Resolution	1.1×10^{-7} of Digiquartz pressure range at default 15-sec sample period (0.8 mm [0.0011 psia] with 10,000 psia sensor) **
Reference Frequency	
Initial Accuracy	1 ppm
Temperature Characterization	-10 to 30° C: $\pm 0.1 \times 10^{-6}$ 0 to 10° C: $\pm 0.05 \times 10^{-6}$
Aging	3×10^{-6} first year, 1×10^{-6} after first year (typical)
Clocks	
Clocks	Counter Time Base (for pressure and pressure temperature): Quartz TCXO ± 3 ppm first year aging (± 1 ppm after first year), ± 0.1 ppm (0 - 20 °C) Real-Time Clock (for time stamp and sample timing): Quartz TCXO watch-crystal type 32,768 Hz; accuracy ± 2 ppm (5 sec/month). Battery-backed for minimum of 8-year operation (derating to 70% of capacity), without external power or main batteries.

* *Digiquartz residual temperature sensitivity is measured at Sea-Bird, and the Digiquartz calibration coefficients are adjusted so that the residual temperature sensitivity is less than 1 ppm over the range of 0 – 20 °C (0.05 ppm/°C; 0.0005 psia for a 10,000 psia range sensor).*

** *The sum of all uncertainties in a measurement of pressure change is less than 1 mm over a duration of a few minutes and less than 5 mm over a duration of minutes to hours, including ocean/instrument temperature changes of 0.25° C.*

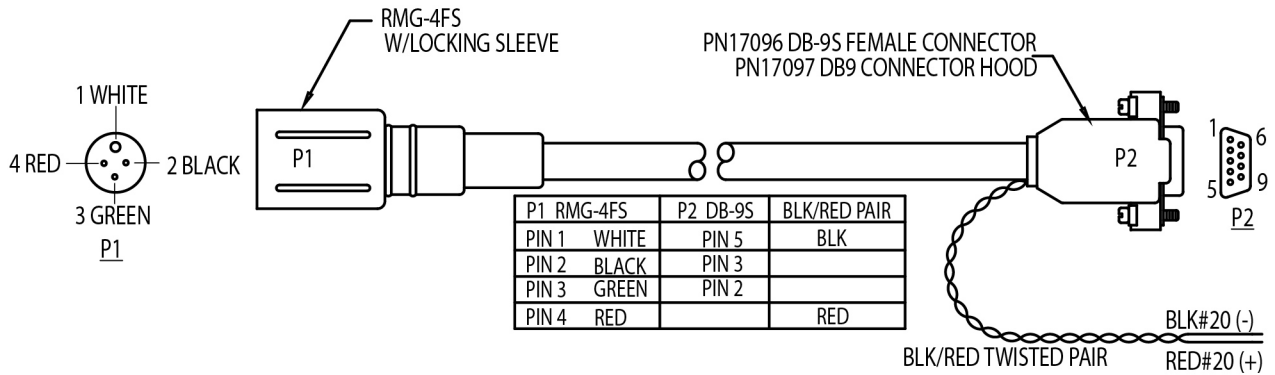
Other Specifications	
Memory	128 MB Flash RAM, providing space for 8.9 million samples. At default sampling period of 15 sec, memory endurance is 51 months.
Power Requirements	<p>* Logging (running continuously): 0.015 Watt at 12V 0.015 Watt at 15V 0.016 Watt at 20V 0.018 Watt at 24V 0.022 Watt at 28V</p> <p>* These values are excluding RS-232 lines, which can vary significantly. Measure the power draw of any RS-232 load. A typical PC adds approximately 0.0017 Amp * 7V = 0.012 Watt.</p> <p>Reference Frequency measurement (1/week while logging): 120 Watt-sec / measurement Peak current (during reference oscillator startup) is 0.225 Amps at 12V.</p> <p>Standard: external power source 12 - 28 VDC.</p> <p>Optional:</p> <p>12 alkaline D-cell batteries (Duracell MN1300, LR20) - Typical capacity 756,000 Joules. Sea-Bird recommends derating 20% for safety, and 5% per year for battery self-discharge. Consider derating further for cold water applications. Battery endurance 14 months (derating as described above).</p> <p>6 lithium DD-cell batteries (Electrochem BCX85-3B76-TC) with buttons (lithiums not supplied by Sea-Bird). Note that 1 lithium DD is shorter than 2 alkaline D-cells, so different battery cover plate required (cover plate available from Sea-Bird). Typical capacity 2,332,800 Joules. Sea-Bird recommends derating 20% for safety, and 3% per year for battery self-discharge. Battery endurance 37 months (derating as described above).</p>
Power Supply	
Housing Materials	7000-meter titanium housing and end cap
Weight	Long housing (with battery compartment) with alkaline batteries: 14.5 kg (32 lbs) in air, 8.6 kg (19 lbs) in water

Dimensions and End Cap Connectors

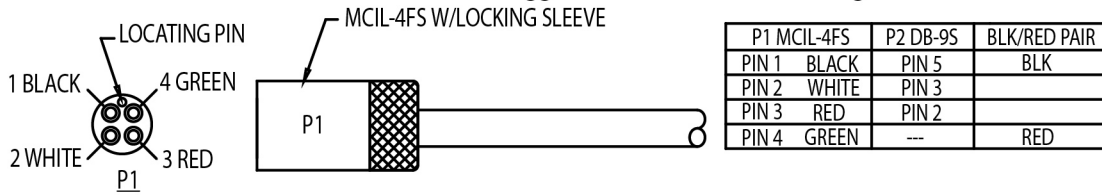


Cables and Wiring

RMG Connector Cable Wiring -- DN 32277



MCIL Wet-Pluggable Connector Cable Wiring -- DN 32366



Power Supply

The standard SBE 54 is externally powered from a 12-28 VDC source.

Optionally, the SBE 54 is available in a longer housing with a battery compartment. The main batteries for this option are 12 D-cell alkaline batteries (Duracell MN 1300, LR20). The SBE 54 can also be powered by 6 lithium DD-cell batteries with buttons (lithium batteries **not** supplied by Sea-Bird). The internal batteries are diode-OR'd with any external source (12-28 VDC), so power is drawn from whichever voltage source is higher.

On-board lithium batteries (non-hazardous units which are unrestricted for shipping purposes) are provided to back-up the buffer and the real-time clock in the event of main battery failure, exhaustion, or removal. The main batteries can be replaced without affecting either the real-time clock or the memory.

Battery Endurance

Note:
1 Watt-second = 1 Joule

See *Specifications* above for power requirements and alkaline and lithium battery ratings.

Examples: Continuous pressure sampling, 1 reference frequency measurement per week, no RS-232 load.

Example 1: 12 alkaline D cell batteries

For alkaline battery pack, use power draw at 15V (0.015 Watt).

Sampling = 0.015 Watt * 3600 sec/hour * 24 hours/day * 7 days/week = **9072 Joules/week**

Reference frequency measurement = 120 Watt-sec = 120 Joules = **120 Joules/week**

Alkaline battery capacity and derating:

Alkaline battery capacity = 756,000 Joules * 0.80 (derate for safety) = 604,800 Joules

Derating 5% per year for battery self-discharge: 0.05 * 604,800 Joules / 52 weeks per year = **582 Joules/week**

Total power/week = 9072 + 120 + 582 = **9774 Joules/week**

Battery endurance = 604,800 Joules / 9774 Joules/week = **62 weeks = 14 months = 1.2 years**

Example 2: 6 lithium DD cell batteries

Lithium battery pack has higher voltage than alkaline, assume approximately 22V. Resulting power draw is approximately 0.017 Watt.

Sampling = 0.017 Watt * 3600 sec/hour * 24 hours/day * 7 days/week = **10282 Joules/week**

Reference frequency measurement = 120 Watt-sec = 120 Joules = **120 Joules/week**

Lithium battery capacity and derating:

Lithium battery capacity = 2,332,800 Joules * 0.80 (derate for safety) = 1,866,240 Joules

Derating 3% per year for battery self-discharge: 0.03 * 1,866,240 Joules / 52 weeks per year = **1077 Joules/week**

Total power/week = 10282 + 120 + 1077 = **11479 Joules/week**

Battery endurance = 1,866,240 Joules / 11479 Joules/week = **162 weeks = 37 months = 3.1 years**

Memory Endurance

The SBE 54 comes standard with a 128 MB memory, providing space for 8.9 million samples.

Example: Using SBE 54 setup with default sample period (15 sec), what is the memory capacity?

Measure pressure every 15 sec ($4/\text{minute} * 60 \text{ minutes/hour} * 24 \text{ hours} = 5760 \text{ measurements/day}$).

Measure reference oscillator every 10080 minutes ($1 \text{ measurement/week} = 1/7 \text{ measurement/day}$).

Total samples in memory / day = $5760 + 1/7 = 5760.143$

$8,900,000 \text{ samples} / (5760.143 \text{ samples/day} = 1545 \text{ days} = 51 \text{ months} = 4.2 \text{ years}$

Comparing this to the example for *Battery Endurance*, battery capacity is more limiting than memory capacity.

After uploading data, use the **InitLogging** command to initialize logging. **InitLogging** erases the FLASH memory and sets the byte number to 0 and sample number to 0, to make the entire memory available for recording. If **InitLogging** is not sent, data will be stored after the last recorded sample.

External Power and Cable Length

Note:

See *Real-Time Setup* below for baud rate limitations on cable length for transmitting real-time data.

There are two issues to consider if powering the SBE 54 externally:

- Limiting the communication IR loss to 1 volt if transmitting real-time data; higher IR loss will cause the instrument to transmit data that does not meet the RS-232 communication standard.
- Supplying enough power at the power source so that sufficient power is available at the instrument after considering IR loss.

Each issue is discussed below.

Note:

Common wire resistances:

Gauge	Resistance (ohms/foot)
12	0.0016
14	0.0025
16	0.0040
18	0.0064
19	0.0081
20	0.0107
22	0.0162
24	0.0257
26	0.0410
28	0.0653

Limiting Communication IR Loss to 1 Volt if Transmitting Real-Time Data

The limit to cable length is typically reached when the maximum **communication** current times the power common wire resistance is more than 1 volt.

$$V_{\text{limit}} = 1 \text{ volt} = IR_{\text{limit}}$$

$$\text{Maximum cable length} = R_{\text{limit}} / \text{wire resistance per foot}$$

where I = maximum current required by SBE 54 during communication.

From *Specifications*, the peak current occurs during the startup of the reference oscillator, and is 0.225 Amps at 12V.

Example – For 20 gauge wire, what is maximum distance to transmit power if transmitting real-time data?

For communication, $R_{\text{limit}} = V_{\text{limit}} / I = 1 \text{ volt} / 0.225 \text{ Amps} = 4.44 \text{ ohms}$.

For 20 gauge wire, resistance is 0.0107 ohms/foot.

Maximum cable length = $4.44 \text{ ohms} / 0.0107 \text{ ohms/foot} = 415 \text{ feet} = 126 \text{ m}$

Supplying Enough Power to SBE 54

Another consideration in determining maximum cable length is supplying enough power at the power source so that sufficient voltage is available, after IR loss in the cable, to power the SBE 54 externally.

From *Specifications*, the peak current occurs during the startup of the reference oscillator, and is 0.225 Amps at 12V.

Example – For 20 gauge wire, what is maximum distance to transmit power to SBE 54 from a 16V power supply?

SBE 54 external power specification is 12 – 28 VDC. Therefore, a 6V IR drop (18 V – 12 V) would still provide enough power to SBE 54.

$$V = IR \quad 6 = 0.225 \text{ Amps} * (0.0107 \text{ ohms/foot} * \text{cable length})$$

$$\text{Maximum cable length} = 2492 \text{ ft} = 760 \text{ m}$$

Note that 760 meters > 126 m (maximum distance if SBE 54 is transmitting real-time data), so IR drop in power is not controlling factor for this example.

Data I/O

The SBE 54 receives setup instructions and outputs diagnostic information or previously recorded data via RS-232. The SBE 54 is factory-configured for *real-time communications* at 9600 baud, 8 data bits, 1 stop bit, and no parity. The baud rate can be changed *for data upload from memory* using **SetBaudRate=** (see *Section 3: Setup, Installation, and Upload*), and can range from 1200 to 115,200 baud.

Real-Time Setup

Note:

If using external power, see *External Power and Cable Length* above for power limitations on cable length.

Baud Rate and Cable Length

The length of cable that the SBE 54 can drive is dependent on the baud rate. At 9600 baud (the factory-configured real-time baud rate), the maximum cable length is 100 meters.

Real-Time Data Acquisition

Real-time data can be saved by clicking Capture in Seaterm232 before you begin logging. The data displayed in Seaterm232 will be saved to the designated file. Process the data as desired.

Section 3: Setup, Installation, and Upload

This section covers:

- Installing Seasoft software
- Programming the SBE 54 for deployment
- Command descriptions
- Installing and deploying the SBE 54
- Uploading data from the SBE 54 memory

Software Installation

Notes:

- Help files provide detailed information on SeatermV2.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our FTP site. See our website (www.seabird.com) for the latest software version number, a description of the software changes, and instructions for downloading the software from the FTP site.

Seasoft V2 was designed to work with a PC running Windows XP service pack 2 or later, Windows Vista, or Windows 7.

If not already installed, install Sea-Bird software programs on your computer using the supplied software CD:

1. Insert the CD in your CD drive.
2. Install software: Double click on **SeasoftV2.exe**. Follow the dialog box directions to install the software. The installation program allows you to install the desired components. Install all the components, or just install SeatermV2 (terminal program *launcher* for the SBE 54).

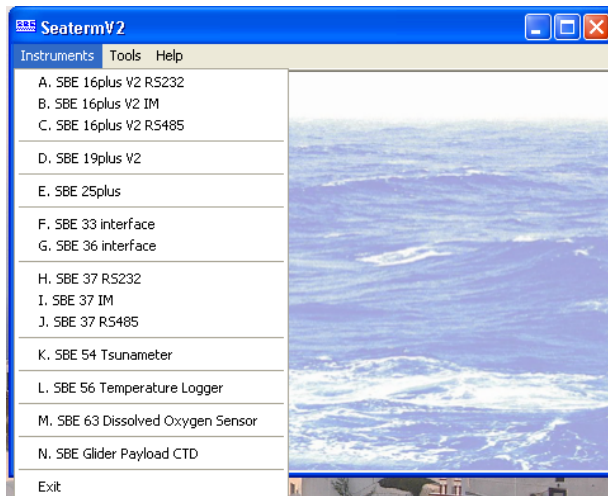
The default location for the software is c:\Program Files\Sea-Bird. Within that folder is a sub-directory for each program.

Programming for Deployment

1. Connect the SBE 54 to the computer using the 4-pin data I/O cable:
 - A. By hand, unscrew the locking sleeve from the SBE 54 I/O (4-pin) connector. If you must use a wrench or pliers, be careful not to loosen the I/O connector instead of the locking sleeve.
 - B. Remove the dummy plug from the SBE 54 I/O connector by pulling the plug firmly away from the connector.
 - C. **Standard Connector** - Install the Sea-Bird I/O cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the SBE 54. **OR**
MCBH Connector – Install the cable, aligning the pins.
 - D. Connect the I/O cable connector to your computer's serial port.

Note:
See SeatermV2's Help files.

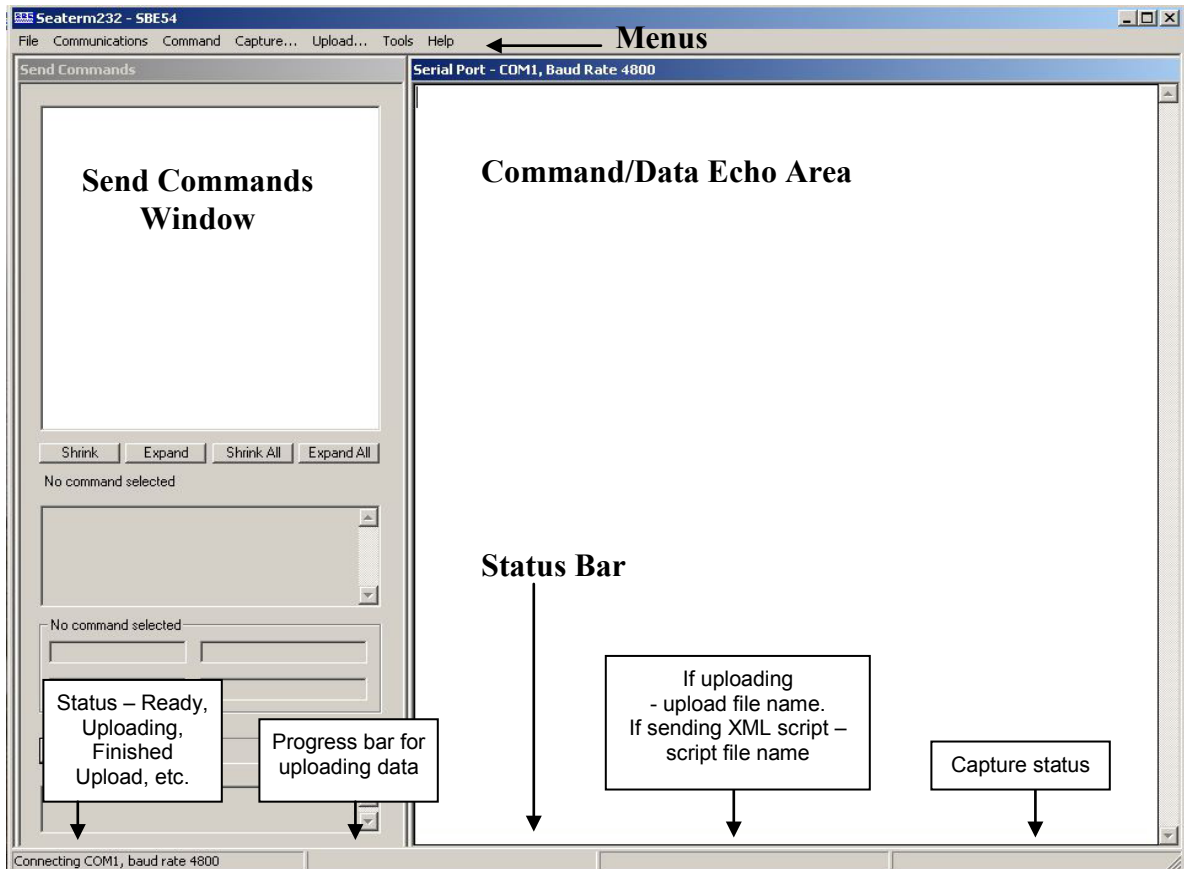
2. Double click on **SeatermV2.exe**. The main screen looks like this:



SeatermV2 is a *launcher*. Depending on the instrument selected, it launches Seaterm232 (RS-232 instruments), Seaterm485 (RS-485 instruments), or SeatermIM (inductive modem instruments).

Note:
See Seaterm232's Help files.

3. In the Instruments menu, select *SBE 54 Tsunamieter*. **Seaterm232** opens; the main screen looks like this:



- Menu – For tasks and frequently executed instrument commands.
- Send Commands window – Contains commands applicable to your SBE 54. The list appears after you connect to the SBE 54.
- Command/Data Echo Area – Title bar of this window shows Seaterm232's current comm port and baud rate. Commands and the SBE 54 responses are echoed here. Additionally, a command can be manually typed or pasted (ctrl + V) here. The SBE 54 must be *connected* for it to respond to a command.
- Status bar – Provides connection, upload, script, and capture status information.

Following is a description of the menus:

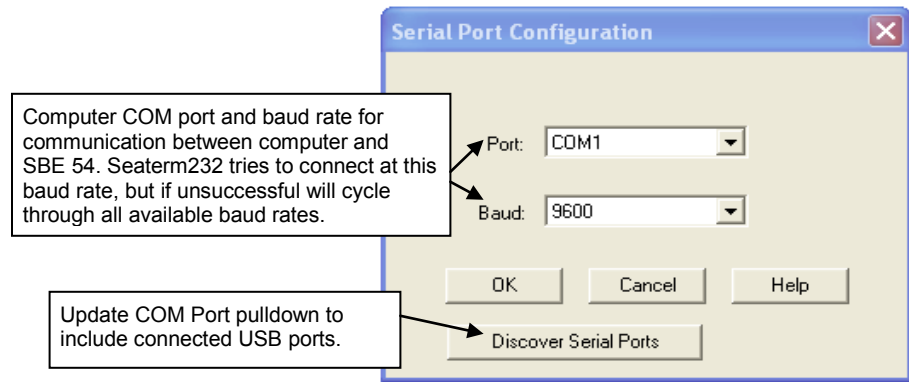
Menu	Description	Equivalent Command*
File	<ul style="list-style-type: none"> • Load command file – opens selected .XML command file, and fills Send Commands window with commands • Unload command file – closes command file, and removes commands from Send Commands window • Exit - Exit program. 	-
Communications	<ul style="list-style-type: none"> • Connect – connect to comm port • Disconnect – disconnect from comm port • Configure – Establish communication parameters (comm port and baud rate). • Disconnect and reconnect – may be useful if SBE 54 has stopped responding 	-
Command	<ul style="list-style-type: none"> • Abort – interrupt and stop SBE 54's response • Send 5 second break (not applicable to SBE 54) • Send stop command • Set local time– Set date and time to time sent by timekeeping software on your computer; accuracy ± 25 msec of time provided by computer. • Set UTC Time (Greenwich Mean Time) – Set date and time to time sent by timekeeping software on your computer; accuracy ± 25 msec of time provided by computer. 	<ul style="list-style-type: none"> • (press Esc key several times for Abort) • Stop • SetTime= • SetTime=
Capture	Capture SBE 54 responses on screen to file, to save real-time data or use for diagnostics. File has .cap extension. Press Capture again to turn off capture. Capture status displays in Status bar.	—
Upload	Upload data stored in memory, in format <i>Convert .XML data file</i> in Tool menu can use. Note: Selecting Upload in menu causes Seaterm232 to automatically stop logging (Stop).	Stop logging with Stop , send several status commands and data upload command (UploadData:b,e). Use Upload menu if you will be converting data using <i>Convert .XML data file</i> in Tools menu)
Tools	<ul style="list-style-type: none"> • Diagnostics log - Keep a diagnostics log. • Convert .XML data file – Convert .XML data file into 2 .txt files, 1 for pressure samples and 1 for reference oscillator samples. • Send script – Send XML script to instrument. May be useful if you have a number of instruments to program with same setup. 	-

Note:

Set local time and *Set UTC time* are disabled if the baud rate in Seaterm232 is set to 115200, because the software cannot reliably set the time at that baud.

*See *Command Descriptions* in this section.

4. If this is the first time Seaterm232 is being used, the configuration dialog box displays:



Make the desired selections, and click OK.

Note:

Seaterm232's baud rate must be the same as the SBE 54 baud rate. Baud for real-time output is factory-set in the SBE 54 to 9600, but can be changed by the user for data upload (set with **SetBaudRate=**). Other communication parameters – 8 data bits, 1 stop bit, and no parity – cannot be changed.

5. Seaterm232 tries to automatically connect to the SBE 54. As it connects, it sends **GetHD** and displays the response, and data then begins to appear. Seaterm232 also fills the Send Commands window with the correct list of commands for your SBE 54. **If there is no communication:**
- In the Communications menu, select *Configure*. The Serial Port Configuration dialog box appears. Select the Comm port and baud rate for communication, and click OK.
 - In the Communications menu, select *Connect* (if *Connect* is grayed out, select *Disconnect and reconnect*).
 - If there is still no communication, check cabling between the computer and SBE 54, and try to connect again.
 - If there is still no communication, repeat Step A with a different baud rate and/or comm port, and try to connect again.
6. Display setup information by sending **GetCD**. The display shows the device type, serial number, calibration coefficients, sampling period, etc.
7. Send **Stop** to stop sampling. The SBE 54 does not echo the command, but sends `</Executed>` followed by `S>`. You may need to press the Esc key before sending **Stop** if the SBE 54 is taking a sample. Send the desired commands to set up the SBE 54 (see *Command Descriptions* below). Verify the setup changes by sending **GetCD** again.
8. The SBE 54 automatically begins sampling again after 2 minutes has elapsed since the last command. Alternatively, send **Start** to begin sampling. The display looks like this:
- ```
S>START
</Executed>
```
- Each time a pressure measurement is completed, the SBE 54 outputs real-time data, which looks like this:
- ```
<Sample Num='501' Type='Pressure'>
<Time>2006-09-06T10:54:31</Time>
<PressurePSI>16.9351</PressurePSI>
<PTemp>22.4224</PTemp>
</Sample>
```
9. Send **Stop** to stop sampling. The SBE 54 does not echo the command, but sends `</Executed>` followed by `S>`. You may need to press the Esc key before sending **Stop** if the SBE 54 is taking a sample.
10. (if ready for deployment)
- Type **InitLogging** and press the Enter key to make the entire memory available for recording. If **InitLogging** is not sent, data will be stored after the last recorded sample.
 - Type **Start** and press the Enter key to begin logging. The SBE 54 should begin to display data.

Command Descriptions

This section describes commands and provides sample outputs. See *Appendix I: Command Summary* for a summarized command list.

General Command Notes

- Input commands in upper or lower case letters and register commands by pressing the Enter key. The SBE 54 terminates all commands on carriage return, and ignores line feeds.
- The SBE 54 sends `<Error type='INVALID COMMAND' msg='RCVD:test' />` if an invalid command is entered.
- The SBE 54 responds only to **GetSD**, **GetCD**, **GetHD**, **GetEC**, and **Stop** while sampling. If you query the SBE 54 while it is sampling (for example, to send **GetSD** to check on sampling progress), it does not interrupt sampling.
- To send commands that will modify the SBE 54's setup, you must first stop sampling (**Stop**).
- If a new command is not received within 2 minutes after stopping sampling, the SBE 54 returns to sampling.
- Initializing logging sets the byte number to 0, so the entire memory is available for recording data. **Initializing logging should only be performed after all previous data has been uploaded.**
- If the SBE 54 is uploading data or performing a diagnostic test and you want to stop it, press the Esc key or select *Abort* in the command menu.

Entries made with the commands are permanently stored in the SBE 54 and remain in effect until you change them.

- The only exception occurs if the electronics are removed from the housing and the two PCBs are separated or the lithium jumper (JP7) is removed (see *Appendix III: Electronics Disassembly/Reassembly*). Before beginning disassembly, upload all data in memory. Upon reassembly, reset the date and time (**SetTime=**) and initialize logging (**InitLogging**).

Commands

Status Commands

GetCD

Get and display configuration data, which includes all parameters related to setup of SBE 54, including communication settings and calibration data. Most of these parameters can be user-input/modified. List below includes, where applicable, command used to modify parameter:

- Device type, Serial number
- Calibration coefficients – initially factory set and should agree with Calibration Certificates shipped with SBE 54.
- Battery type [**SetBatteryType=**]
- Baud rate [**SetBaudRate=**]
- Enable alerts? [**SetEnableAlerts=**]
- Upload type [**SetUploadType=**]
- Sample interval time [**SetSamplePeriod=**]

Example: Send **GetCD** to SBE 54 (user input in bold)

```
S>getcd
<ConfigurationData DeviceType='SBE54' SerialNumber='00000000'>
<CalibrationCoefficients>
<AcqOscCalDate>2007-03-01</AcqOscCalDate>                               SetAcqOscCalDate=
<FRA0>5.999944E+06</FRA0>                                               [SetFRA0=]
<FRA1>2.444072E-03</FRA1>                                               [SetFRA1=]
<FRA2>-9.320929E-09</FRA2>                                             [SetFRA2=]
<FRA3>-8.939748E-13</FRA3>                                             [SetFRA3=]
<PressureSerialNum>101531</PressureSerialNum>                          [SetPressureSerialNum=]
<PressureCalDate>2007-03-01</PressureCalDate>                          [SetPressureCalDate=]
<pu0>5.801935E+00</pu0>                                                 [SetPU0=]
<py1>-3.987587E+03</py1>                                               [SetPY1=]
<py2>-1.173108E+04</py2>                                               [SetPY2=]
<py3>0.000000E+00</py3>                                               [SetPY3=]
<pc1>-4.856338E+04</pc1>                                               [SetPC1=]
<pc2>2.272540E+03</pc2>                                               [SetPC2=]
<pc3>1.708704E+05</pc3>                                               [SetPC3=]
<pd1>3.652600E-02</pd1>                                               [SetPD1=]
<pd2>0.000000E+00</pd2>                                               [SetPD2=]
<pt1>2.979398E+01</pt1>                                               [SetPT1=]
<pt2>1.928403E+00</pt2>                                               [SetPT2=]
<pt3>6.145672E+01</pt3>                                               [SetPT3=]
<pt4>1.081033E+02</pt4>                                               [SetPT4=]
<poffset>0.000000E+00</poffset>                                        [SetPOffset= (in psia)]
<prange>1.000000E+04</prange>                                          [SetPRange= (in psia)]
</CalibrationCoefficients>
<Settings
batteryType='0'                                                         [SetBatteryType=]
baudRate='9600'                                                         [SetBaudRate=]
enableAlerts='1'                                                       [SetEnableAlerts=]
uploadType='1'                                                         [SetUploadType=]
samplePeriod='15'                                                       [SetSamplePeriod=]
/>
<Executed/>$
```

Status Commands (*continued*)**GetSD**

Get and display status data, which contains data that changes while deployed.

List below includes, where applicable, command used to modify parameter:

- Device type, Serial number
- Date and time [**SetTime=**]
- Main battery voltage
- Number of samples in memory, number of bytes in memory, number of additional bytes that can be placed in memory [reset with **InitLogging**]
- Number of recorded events in event counter [reset with **ResetEC**]

Example: Send **GetSD** to SBE 54 set up with **SetDebugLevel=2** (standard output) (user input in bold)

```
S>getsd
<StatusData DeviceType='SBE54' Version='TEST' SerialNumber='00000000'>
<DateTime>2000-01-01T00:31:17+08:00</DateTime>
<EventSummary numEvents='245' />
<Power>
<MainSupplyVoltage>15.5</MainSupplyVoltage>
</Power>
<SampleDataSummary>
<NumSamples>788424</NumSamples>
<NumBytes>12649984</NumBytes>
<NumBytesFree>121567744</NumBytesFree>
</SampleDataSummary>
</StatusData>
<Executed/>$
```

[**SetTime=**]
[can clear with **ResetEC**]

[can clear with **InitLogging**]
[can clear with **InitLogging**]
[can clear with **InitLogging**]

GetEC

Get and display event counter data. Event counters record number of occurrences of common timeouts, power-on resets, watchdog timer rests, and other conditions. Event counter data can help to identify root cause of a malfunction.

Example below includes some possible events that may be logged in the counter:

Example: Send **GetEC** to SBE 54 (user input in bold)

```
S>getec
<EventSummary numEvents='18' />
<EventList DeviceType='SBE54' SerialNumber='00000000'>
<Event type='PowerOnReset' count='4' />
<Event type='PowerFailReset' count='4' />
<Event type='WatchDogReset' count='2' />
<Event type='SerialByteErr' count='3' />
<Event type='CmdBuffOflow' count='1' />
<Event type='SerialRxOflow' count='1' />
<Event type='LowBattery' count='1' />
<Event type='OutOfMemory' count='1' />
<Event type='SignalErr' count='1' />
</EventList>
<Executed/>$
```

[can clear with **ResetEC**]

Status Commands (*continued*)**GetHD**

Get and display hardware data, which is fixed data describing SBE 54:

- Device type, Serial number
- Manufacturer
- Firmware version
- Firmware date
- Hardware version
- PCB serial number
- Manufacture date

Example: Send **GetHD** to SBE 54 (user input in bold)

```
S>gethd
<HardwareData DeviceType='SBE54' SerialNumber='00000000'>
<Manufacturer>Sea-Bird Electronics, Inc</Manufacturer>
<FirmwareVersion>SBE54 V1.2-6MHZ</FirmwareVersion>
<FirmwareDate>Sep 26 2006</FirmwareDate>
<HardwareVersion>NOT SET</HardwareVersion>
<HardwareVersion>NOT SET</HardwareVersion>
<PCBSerialNum>NOT SET</PCBSerialNum>
<PCBSerialNum>NOT SET</PCBSerialNum>
<PCBType>1</PCBType>
<MfgDate>Aug 18 2006</MfgDate>
</HardwareData>
<Executed/>$
```

Setup – Communication Commands**Notes:**

- The SBE 54 baud rate set with **SetBaudRate=** must be the same as Seaterm232's baud rate (set in Communications > *Configure*).
- The SBE 54 always transmits real-time data at 9600 baud, regardless of the setting for **SetBaudRate=**.

SetBaudRate=x

x= baud rate for *upload* (1200, 2400, 4800, 9600, 19200, 33600, 38400, 57600, or 115200). **Default 9600**. Check capability of your computer and terminal program before increasing baud; high baud requires a short cable and good PC serial port with accurate clock.

Setup - General Commands

*Init	Reset all Configuration Data (except calibration coefficients) to factory defaults. Sends following commands: SetBaudRate=9600 SetSamplePeriod=15 SetBatteryType=0 SetEnableAlerts=1 SetUploadType=1
SetSamplePeriod=x	x = duration (sec) of each pressure measurement. SBE 54 integrates pressure sensor output, calculating and storing average pressure for each SetSamplePeriod . Time reported with pressure data is time at end of pressure measurement. Range 1 – 240; default 15 sec . Larger sample periods provide better resolution: Resolution (% of full scale) = $0.001 / (6 * \text{SamplePeriod})$
SetTime=x	x = real-time clock date and time in ISO8601-2000 extended format (yyyy – mm-ddThh:mm:ss) <i>where</i> yyyy = year, mm = month, dd = day, hh = hour, mm = minute, and ss = second. Can include time zone reference, with Z for Zulu time and + for hour and minute offset from GMT time (+hh:mm).

Examples: Set current date and time to 31 July 2006 12:35:00 (user input in bold).

No time zone designation -

S>**SETTIME=2006-07-31T12:35:00**

Zulu time -

S>**SETTIME=2006-07-31T12:35:00Z**

1 hour and 15 minute offset from GMT time -

S>**SETTIME=2006-07-31T12:35:00+01:15**

Note:

Battery voltage measurement is approximate, and does not account for diode drops (0.6 V typical).

SetBatteryType=x

x=0: Lithium battery. SBE 54 begins displaying low battery alerts and stops automatic reference oscillator sampling at 15 V. Battery type automatically changes to lithium (0) when SBE 54 powers up. **Default**.

x=1: Alkaline battery. SBE 54 starts alerts and stops reference oscillator sampling at 11 V.

Setup – Data Output Commands

SetEnableAlerts=x

x=0: Do not output alerts.

Note:

If there are any alerts, they are generally output on power-up or after real-time samples.

x=1: Output alerts for any of the following conditions: low battery, full memory, invalid frequency from pressure transducer (caused by break in connection between transducer and circuit board). If alerts are enabled, customer real-time data analysis software must be able to interpret this data as an alert instead of pressure sensor data. **Default**.

Sampling Commands

The first time sampling starts after receipt of initialize logging (**InitLogging**), data recording starts at the beginning of memory and any previously recorded data is written over. Each time the SBE 54 is commanded to start sampling again, recording continues, with new data stored after previously recorded data.

Note:

Do not initialize logging until all data has been uploaded.

InitLogging

Initialize logging - after all previous data has been uploaded, initialize logging before starting to sample again to make entire memory available for recording. Erases FLASH memory and sets byte number to 0 and sample number to 0 internally (first byte recorded will be byte 0 and first sample recorded will be sample 1). If **InitLogging** is not sent, data will be stored after last recorded sample. **Do not send InitLogging until all existing data has been uploaded.**

Notes:

- The SBE 54 responds to **GetSD**, **GetCD**, **GetHD**, and **GetEC** without interrupting sampling; however, prompts and echoing are disabled while sampling. The SBE 54 responds to any other command with

```
<Error type='NOT ALLOWED'
msg='Command not allowed
while sampling' />
```

until you stop sampling with **Stop**.
- You must stop sampling with **Stop** before uploading data with **UploadData:b,e**. Seaterm232's Upload menu sends **Stop** automatically before uploading data.
- You must stop sampling with **Stop** before uploading data with **GetSamples:b,x**, **GS:b,x**, **GetLastPSamples:x**, or **GLPS:x**.

Start

Start sampling now. SBE 54 samples, stores data in memory, and outputs data at end of each sample period (**SetSamplePeriod=**). Output for each sample is sample number, date and time, pressure (psi), and pressure sensor temperature (°C).

Example real-time output:

```
<Sample Num='501' Type='Pressure'>
<Time>2006-09-06T10:54:31</Time>
<PressurePSI>16.9351</PressurePSI>
<PTemp>22.4224</PTemp>
</Sample>
```

Stop

Stop sampling now. SBE 54 resumes sampling automatically after no valid commands are entered for 2 minutes.

Sampling Commands (*continued*)**SampleRefOsc**

Test reference oscillator, taking one measurement of acquisition oscillator using reference oscillator. SBE 54 outputs acquisition oscillator frequency, PCB thermistor value, and deviation (in ppm) of acquisition oscillator frequency from current calibration settings. Reference oscillator takes 2 minutes to stabilize output frequency before taking measurement. Abort measurement by pressing Esc key or selecting Command > *Abort*.

Example:

```
S>samplerefosc
<SetTimeout>125000</SetTimeout>
<SetTimeoutMax>150000</SetTimeoutMax>
<SetTimeoutICD>125000</SetTimeoutICD>
<!--Ref osc warmup next 120 seconds-->
<!--Warmup complete, starting measurement at 0.1Hz-->
<Sample Num='6' Type='RefOsc'>
<Time>2000-01-01T21:15:07</Time>
<RefOscFreq>6000091.773</RefOscFreq>
<PCBTempRaw>16670</PCBTempRaw>
<RefErrorPPM>18.876</RefErrorPPM>
</Sample>
<Executed/>
```

Data Access and Upload Commands**GetSamples:b,x**

Upload **x** samples, beginning at sample **b**. Stop sampling (**Stop**) before sending this command. To interrupt and cancel upload, press Esc key or select Command > *Abort*.

GS:b,x

Same as **GetSamples:b,x**.

GetLastPSamples:x

Upload last **x** pressure samples (1 - 1024). Reference oscillator samples are omitted. Stop sampling (**Stop**) before sending this command. To interrupt and cancel upload, press Esc key or select Command > *Abort*.

Notes:

- Send **GetSD** to determine how many samples are in memory before sending **GetSamples:b,x**, **GS:b,x**, **GetLastPSamples:x**, or **GLPS:x**.
- To save data from any of the **Get** commands documented here to a file, click Capture before entering the command.
- Send **GetRSampleList** to determine how many reference samples are in memory before sending **GetLastRSamples:x**.

Example: Upload the last 2 pressure samples.

```
S>getlastpsamples:2
<PSAMPLES>
<Sample Num='22' Type='Pressure'>
<Time>2000-01-01T20:55:44</Time>
<PressurePSI>11.8952</PressurePSI>
<PTemp>20.7633</PTemp>
</Sample>

<Sample Num='23' Type='Pressure'>
<Time>2000-01-01T20:55:44</Time>
<PressurePSI>11.8957</PressurePSI>
<PTemp>20.7637</PTemp>
</Sample>
</PSAMPLES>
<Executed/>
```

GLPS:x

Same as **GetLastPSamples:x**

Data Access and Upload Commands (*continued*)

Notes:

- To save data from any of the **Get** commands documented here to a file, click Capture before entering the command.
- Send **GetRSampleList** to determine how many reference samples are in memory before sending **GetLastRSamples:x**.

GetRSampleList

Upload a list of sample numbers of reference samples in memory.

GetLastRSamples:x

Upload last *x* reference oscillator samples (1 - 1024). Stop sampling (**Stop**) before sending this command. To interrupt and cancel upload, press Esc key or select Command > *Abort*.

Example: Upload the last 2 reference samples.

```
>getlastrsamples:2
<RSAMPLES>
<Sample Num='24' Type='RefOsc'>
<Time>2000-01-01T20:58:24</Time>
<RefOscFreq>6000102.880</RefOscFreq>
<PCBTempRaw>16781</PCBTempRaw>
<RefErrorPPM>20.702</RefErrorPPM>
</Sample>

<Sample Num='25' Type='RefOsc'>
<Time>2000-01-01T20:58:34</Time>
<RefOscFreq>6000102.731</RefOscFreq>
<PCBTempRaw>16765</PCBTempRaw>
<RefErrorPPM>20.681</RefErrorPPM>
</Sample>
</RSAMPLES>
<Executed/>
```

GLRS:x

Same as **GetLastRSamples:x**.

SetUploadType=x

x=0: Upload in *Ascii text* in response to **UploadData:b,e**.

x=1: Upload in *Binary* in response to **UploadData:b,e**; approximately twice as fast as Ascii text upload. *Default*.

Notes:

- **SetUploadType=** does not affect output from **GetSamples:b,x**, **GS:b,x**, **GetLastPSamples:x**, **GLPS:x**, **GetLastRSamples:x**, or **GLRS:x**.
- Send **GetSD** to determine how many bytes of data are in memory before sending **UploadData:b,e**.
- Selecting Upload in Seaterm232's menu causes Seaterm232 to automatically stop logging (**Stop**) and send a number of other commands to provide uploaded output in the correct format for use by the convert utility in the Tools menu.

UploadData:b,e

Upload **all** data from *byte b* to *byte e*, in raw form. Stop sampling (**Stop**) before sending this command. To interrupt and cancel upload, press Esc key or select Command > *Abort*.

Diagnostic Commands

ResetEC Delete all events in event counter (number of events displays in **GetSD** response, event details display in **GetEC** response).

TestEeprom Test EEPROM to verify it is reading and writing correctly. EEPROM stores event counters, configuration data, calibration coefficients, and state of FLASH memory. To interrupt and cancel test, press Esc key or select Command > *Abort*.

TestRefOsc Test reference oscillator, continuously measuring acquisition oscillator using reference oscillator. After each sample, SBE 54 outputs acquisition oscillator frequency, PCB thermistor value, and deviation (in ppm) of acquisition oscillator frequency from current calibration settings. For first 2 minutes of test, reference oscillator does not provide any output while output frequency stabilizes. **Test continues to run until ended by pressing Esc key or selecting Command > *Abort*.**

Example:

```
S>testrefoscsc
<SetTimeout>120000</SetTimeout>
<SetTimeoutMax>OFF</SetTimeoutMax>
<SetTimeoutICD>120000</SetTimeoutICD>
<!--Ref osc warmup next 120 seconds-->
<!--Warmup complete, starting measurement at 0.1Hz-->
<SetTimeout>15000</SetTimeout>
<SetTimeoutICD>15000</SetTimeoutICD>
<ReferenceOscTest DeviceType='SBE54'
SerialNumber='00000000'>
6000102.880 16781 20.702
6000102.731 16765 20.681
</ReferenceOscTest>
<Executed/>
```

Calibration Coefficients Commands

To view all calibration coefficients, send the **GetCD** command. Calibration coefficient commands listed below modify a particular coefficient.

Notes:

- S = character string,
F = floating point number
- Calibration coefficients are initially factory-set and should agree with the Calibration Certificate shipped with the SBE 54.
- Data is stored in memory as raw data. Therefore, an error in a calibration coefficient has no impact on the data stored in memory.
- The acquisition crystal is the time base for counting the pressure sensor frequency outputs. The acquisition crystal requires four calibration coefficients (**SetFRA0=**, **SetFRA1=**, **SetFRA2=**, and **SetFRA3=**) for temperature correction.

SetAcqOscCalDate=S	S=acquisition crystal calibration date in ISO8601-2000 format.
SetFRA0=F	F=acquisition crystal frequency A0.
SetFRA1=F	F=acquisition crystal frequency A1.
SetFRA2=F	F=acquisition crystal frequency A2.
SetFRA3=F	F=acquisition crystal frequency A3.
SetPressureCalDate=S	S=pressure sensor calibration date in ISO8601-2000 format.
SetPressureSerialNum=S	S=pressure sensor serial number.
SetPRange=F	F=pressure sensor full scale range (psia).
SetPOffset=F	F=pressure sensor offset (psia).
SetPU0=F	F= pressure sensor U0.
SetPY1=F	F= pressure sensor Y1.
SetPY2=F	F=pressure sensor Y2.
SetPY3=F	F= pressure sensor Y3.
SetPC1=F	F= pressure sensor C1.
SetPC2=F	F= pressure sensor C2.
SetPC3=F	F= pressure sensor C3.
SetPD1=F	F= pressure sensor D1.
SetPD2=F	F= pressure sensor D2.
SetPT1=F	F= pressure sensor T1.
SetPT2=F	F= pressure sensor T2.
SetPT3=F	F= pressure sensor T3.
SetPT4=F	F= pressure sensor T4.

Installing and Deploying SBE 54

CAUTION:

Do not use WD-40 or other petroleum-based lubricants, as they will damage the connectors.

1. Install a cable on the data I/O connector on the SBE 54 end cap:
 - A. Lightly lubricate the inside of the cable connector with silicone grease (DC-4 or equivalent).
 - B. **Standard Connector** - Install the connector, aligning the raised bump on the side of the plug with the large pin (pin 1 – ground) on the SBE 54. Remove any trapped air by *burping* or gently squeezing the connector near the top and moving your fingers toward the end cap. **OR**
MCBH Connector – Install the connector, aligning the pins.
 - C. Place the locking sleeve over the connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

Recovering SBE 54

WARNING!

If the SBE 54 stops working while underwater, or shows other signs of flooding or damage, carefully secure it away from people until you have determined that abnormal internal pressure does not exist or has been relieved. Pressure housings may flood under pressure due to dirty or damaged o-rings, or other failed seals. When a sealed pressure housing floods at great depths and is subsequently raised to the surface, water may be trapped at the pressure at which it entered the housing, presenting a danger if the housing is opened before relieving the internal pressure. Instances of such flooding are rare. However, a housing that floods at 5000 meters depth holds an internal pressure of more than 7000 psia, and has the potential to eject the end cap with lethal force. A housing that floods at 50 meters holds an internal pressure of more than 85 psia; this force could still cause injury.

If you suspect the SBE 54 is flooded, point it in a safe direction away from people, and loosen the 3 screws on the connector end cap about ½ turn. If there is internal pressure, the end cap will *follow* the screws out, and the screws will not become easier to turn. In this event, loosen 1 bulkhead connector very slowly, at least 1 turn. This opens an o-ring seal under the connector. Look for signs of internal pressure (hissing or water leak). If internal pressure is detected, let it bleed off slowly past the connector o-ring. Then, you can safely remove the end cap.

Rinse the SBE 54 with fresh water.

Uploading Data from Memory

The SBE 54 can upload data in ASCII text or binary at bauds up to 115,200. Binary upload is approximately **two times faster** than ASCII text. Binary upload of the full memory (128 MB) at 115,200 baud requires approximately 3.5 hours. If binary upload is selected, Seaterm232 uploads the data in binary and then converts it to ASCII text, resulting in a .xml data file that is identical to one uploaded in ASCII text.

1. Double click on **SeatermV2.exe**. The main screen appears.
2. In the Instruments menu, select *SBE 54 Tsunameter*. **Seaterm232** opens.
3. Seaterm232 will try to automatically connect to the SBE 54. As it connects, it sends **GetHD** and displays the response, and data then begins to appear. Seaterm232 also fills the Send Commands window with the correct list of commands for your SBE 54. If there is no communication:
 - A. In the Communications menu, select *Configure*. The Serial Port Configuration dialog box appears. Select the Comm port and baud rate for communication, and click OK.
 - B. In the Communications menu, select *Connect* (if *Connect* is grayed out, select *Disconnect and reconnect*).
 - C. If there is still no communication, check cabling between the computer and SBE 54, and try to connect again.
 - D. If there is still no communication, repeat Step A with a different baud rate and/or comm port, and try to connect again.
4. Click Upload to upload stored data. Seaterm232 responds as follows:
 - A. A Save As dialog box appears. Enter the desired data file name and location, and click *Save*.
 - B. Seaterm232 sends **GetSD** and displays the response. **GetSD** provides information on the instrument status, and number of samples in memory.

Note:

The SBE 54 communicates at 9600 baud (factory-set default), 8 data bits, 1 stop bit, and no parity, as documented on the instrument Configuration Sheet. Baud rate for upload can be changed with **SetBaudRate=**; other parameters cannot be modified.

C. An Upload Data dialog box appears.

The screenshot shows the 'Upload Data' dialog box with the following settings and callouts:

- Upload format:** Radio buttons for 'Text' and 'Binary'. Callout: 'Select to enable ASCII text or binary upload. Binary is approximately twice as fast.'
- Block size [bytes]:** Text box containing '100000'. Callout: 'Enter number of bytes uploaded in each block. Seaterm232 uploads data in blocks, and calculates a checksum at end of each block. If block fails checksum verification, Seaterm232 tries to upload block of data again, cutting block size in half.'
- Memory summary:** Table showing: Bytes: 50469126, BytesFree: 83748602, Samples: 3350597.
- Upload data options:** Radio buttons for 'All data as a single file', 'By scan number range', 'All data separated by cast', 'By address range', 'By cast number range', and 'From a single cast'. Callout: 'Select All data as a single file to upload all data in memory. Select By address range and enter beginning byte number and total number of bytes to upload all data within that range. Note that first byte in memory is byte 0 (not byte 1). You must select a starting address of 0 or a multiple of 512 to enable Convert utility to properly convert uploaded data.'
- Address range:** Text boxes for 'Beginning with byte #' (0) and 'Number of bytes to upload' (50469126).
- Baud rate for upload:** Dropdown menu set to '115200'. Callout: 'SBE 54 can upload data at a different rate than it uses for general communication (9600 baud). Check capabilities of your computer before increasing baud. Not applicable unless device type = SBE54.'
- Upload file:** Text box containing 'C:\volatile\SBE54_05400011_2008_11_03.XML'. Callout: 'File name selected in Step A is shown here. To change file name/location, click Browse. Upload file has .xml extension.'
- Buttons:** 'Help', 'Start', 'Save & Exit', and 'Cancel'.

Make the desired selections, and then click Start.

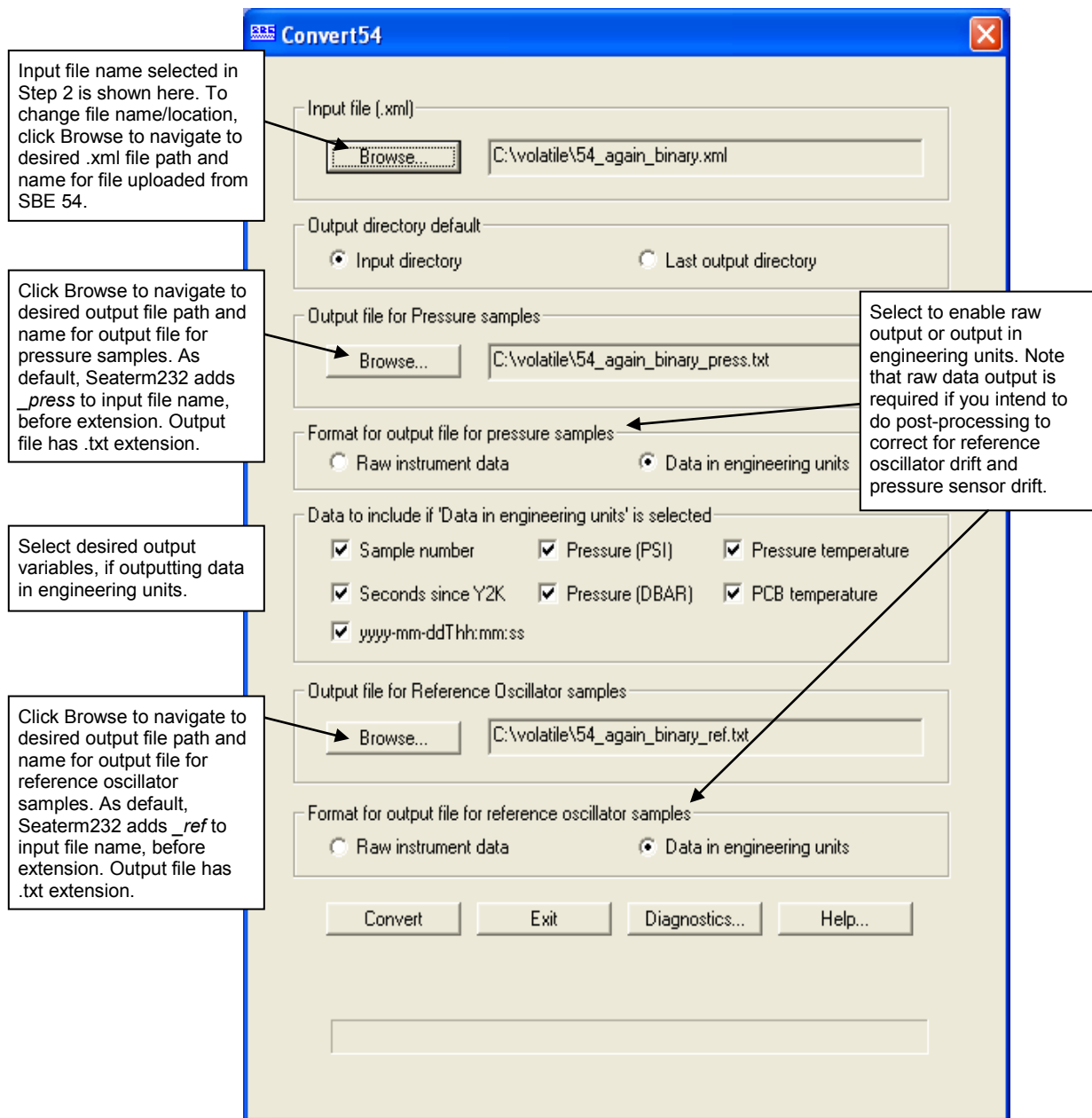
Note:
Data cannot be uploaded while sampling.

- D. Seaterm232 sends **GetHD** and **GetCD** and displays the responses.
 - E. Seaterm232 sends **Stop** to stop sampling.
 - F. Seaterm232 sends **SetUploadType=** (0 for ASCII text, 1 for binary), based on your selection in the Upload Data dialog box.
 - G. Seaterm232 sends the data upload command (**UploadData:b,e**), based on your selection of upload range in the Upload Data dialog box and writes the data to the upload file. The Status bar at the bottom of the window displays the upload progress.
5. Ensure all desired data has been uploaded by processing the data.

Converting Uploaded Data

Seaterm232 uses the input .xml file of data uploaded from the SBE 54, and separates the data into two .txt files – one for pressure samples, and one for reference oscillator samples. The user can select to output raw data or data in engineering units (Seaterm232 uses calibration coefficients in the .xml file to convert raw data to engineering units). Both of the output .txt files contain tab-delimited columns of data, which can then be processed as desired.

1. In Seaterm232's Tools menu, select *Convert .XML data file*. An Open dialog box appears.
2. Browse to the desired .XML data file, and click OK.
3. The Convert54 dialog box appears:



Make the desired selections, and click Convert.

Section 4: Routine Maintenance and Calibration

This section reviews corrosion precautions, connector mating and maintenance, battery replacement, pressure sensor maintenance, and sensor calibration. The accuracy of the SBE 54 is sustained by the care and calibration of the sensors and by establishing proper handling practices.

Corrosion Precautions

Rinse the SBE 54 with fresh water after use and prior to storage.

All exposed metal is titanium. No corrosion precautions are required, but avoid direct electrical connection of the titanium to dissimilar metal hardware.

Connector Mating and Maintenance

Note:

See *Application Note 57: Connector Care and Cable Installation*.

Clean and inspect connector and cable before every deployment and as part of your yearly equipment maintenance. Inspect connector that is unmated for signs of corrosion product around the pins, and for cuts, nicks or other flaws that may compromise the seal.

When remating:

CAUTION:

Do not use WD-40 or other petroleum-based lubricants, as they will damage the connectors.

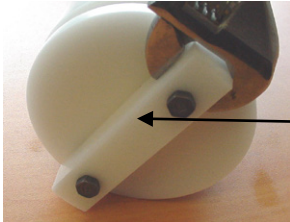
1. Lightly lubricate the inside of the cable connector with silicone grease (DC-4 or equivalent).
2. **Standard Connector** - Install the cable connector, aligning the raised bump on the side of the cable connector with the large pin (pin 1 - ground) on the SBE 54. Remove any trapped air by *burping* or gently squeezing the connector near the top and moving your fingers toward the end cap.
OR
MCBH Connector – Install the cable connector, aligning the pins.
3. Place the locking sleeve over the cable connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

Verify that a cable is installed on the bulkhead connector before deployment.

Battery Replacement

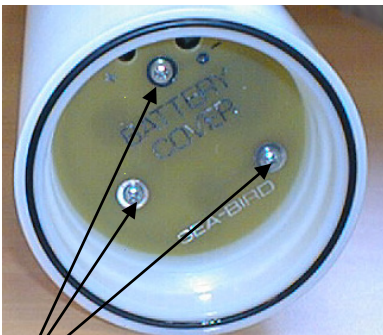


Alkaline D-cell
(MN1300, LR20)



Unthread cap by
rotating counter-
clockwise

Note: Photo is SeaCAT with
plastic housing; battery detail
the same for SBE 54



Remove Phillips-head
screws and washers

Note: Alkaline and lithium batteries require
different cover plates, because 1 lithium DD cell
is shorter than 2 alkaline D cells.



For lithium DD cells

For alkaline D cells

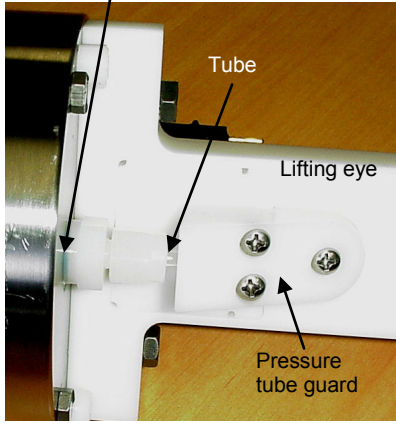
The SBE 54 with optional long housing uses 12 alkaline D-cells (Duracell MN1300, LR20) or 6 lithium DD-cells (Electrochem BCX85-3B76-TC) in the battery compartment.

Leave the batteries in place when storing the SBE 54 to prevent depletion of the back-up lithium batteries by the real-time clock. Even *exhausted* main batteries power the clock (less than 25 microamperes) almost indefinitely. If the SBE 54 is to be stored for long periods, **replace alkaline batteries yearly to prevent battery leakage** (which could damage the SBE 54).

1. Remove the battery end cap (end cap without connectors):
 - A. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
 - B. Remove the end cap by rotating counter-clockwise (use a wrench on the white plastic bar if necessary).
 - C. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue.
 - D. Put the end cap aside, being careful to protect the O-ring from damage or contamination.
2. Remove the battery cover plate from the housing:
 - A. Remove the three Phillips-head screws and washers from the battery cover plate inside the housing.
 - B. The battery cover plate will pop out. Put it aside.
3. Turn the SBE 54 over and remove the batteries.
4. Install the new batteries, with the + terminals against the flat battery contacts and the - terminals against the spring contacts.
5. Reinstall the battery cover plate in the housing:
 - A. Align the battery cover plate with the housing. The posts inside the housing are not placed symmetrically, so the cover plate fits into the housing only one way. Looking at the cover plate, note that one screw hole is closer to the edge than the others, corresponding to the post that is closest to the housing.
 - B. Reinstall the three Phillips-head screws and washers, while pushing hard on the battery cover plate to depress the spring contacts at the bottom of the battery compartment. **The screws must be fully tightened, or battery power to the circuitry will be intermittent.**
6. Check the battery voltage at BAT + and BAT - on the battery cover plate. For standard alkaline batteries, it should be approximately 18 volts. For lithium DD cell batteries, it should be approximately 21 volts.
7. Reinstall the battery end cap:
 - A. Remove any water from the O-rings and mating surfaces with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of o-ring lubricant (Parker Super O Lube) to O-rings and mating surfaces.
 - B. Carefully fit the end cap into the housing and screw the end cap into place. Use a wrench on the white plastic bar to ensure the end cap is tightly secured.

Pressure Sensor Maintenance

Pressure sensor port



Connector End Cap

The pressure fitting – which includes a pressure port fitting, external tube, and polyurethane bladder bag – is filled with silicone oil at the factory. The oil transmits hydrostatic pressure via internal, capillary tubing to the pressure sensor inside the instrument, and prevents corrosion that might occur if the sensor diaphragm was exposed to water. The bladder bag is vacuum back-filled.

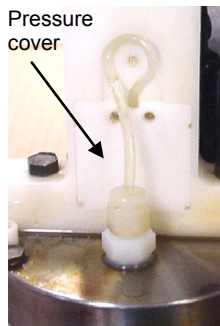
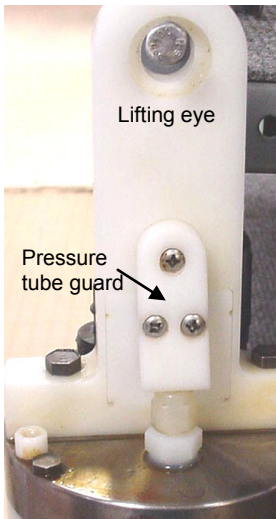
The bladder bag can develop tears and leaks over time. If the fitting has been damaged, or investigation due to poor data shows that the bag has torn, replace the fitting and bag and refill the oil. **Sea-Bird highly recommends that you send the SBE 54 back to the factory for this repair, as it is difficult to completely remove all air from the system in the field, resulting in potential pressure errors.** However, if you must do the repair to meet a deployment schedule, contact Sea-Bird to purchase the needed parts.

Parts required:

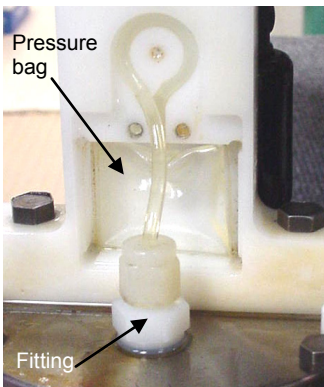
Part Number	Description	Quantity
30551	Pressure port bladder bag	2 *
50025	Pressure sensor oil refill kit (provided with SBE 54 shipment) **	1
50029	Nylon capillary assembly	2 *
30002	Swagelock, nylon, NY-200-1-OR	2 *
30521	Syringe, 60 cc, DURR #899069, MFG #309663 (18 gage needle ground)	1

* Only 1 is required, but we recommend that you purchase a spare in case you have difficulty with the procedure.

** If you have a bell jar, use it to de-gas the oil in the oil refill kit.

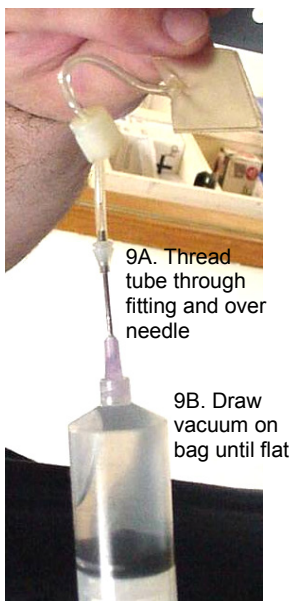
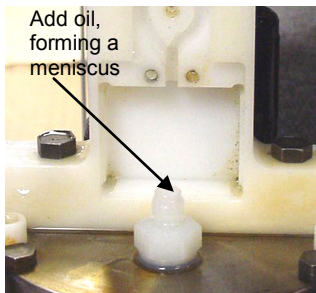
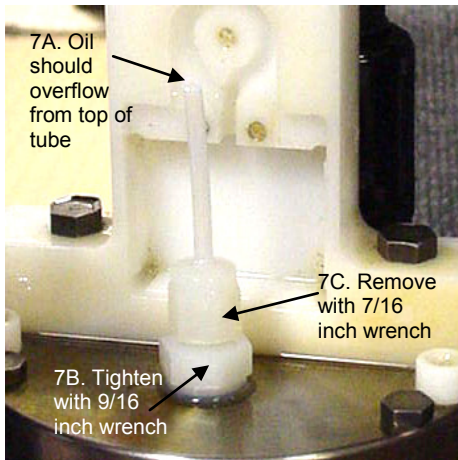
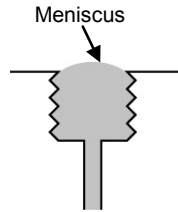
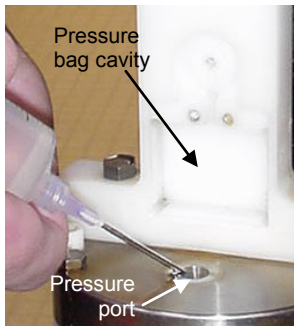


1. Securely mount the SBE 54 vertically (connector end cap up).
2. Remove the 3 Phillips-head screws attaching the pressure tube guard to the lifting eye. Remove the pressure tube guard and the pressure cover that is under it.

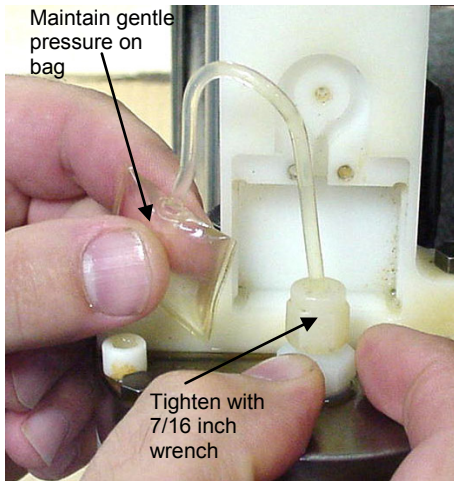


3. Remove the fitting from the end cap with a 9/16 inch wrench. Discard the fitting, tubing, and pressure bag.

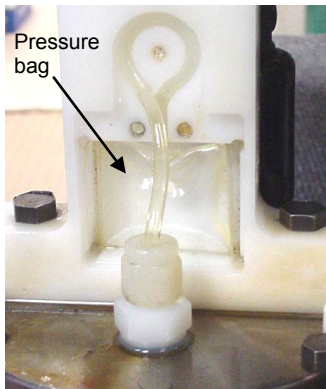
CAUTION:
Do not put a brush or any object in the pressure port. Doing so may damage or break the pressure sensor.



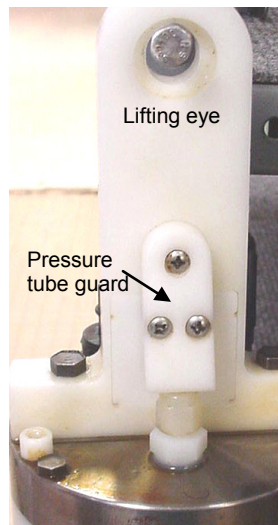
4. Clean the pressure bag cavity in the lift eye and the removed pressure tube guard and pressure cover, removing all residue/grit. Ensure that the holes in each corner of the pressure bag cavity in the lift eye are free of obstructions.
5. Clean the sensor end cap, being careful to remove any residue/grit near the pressure port.
6. From the 50025 pressure sensor oil refill kit, fill the small syringe with the supplied oil. Fill the pressure port, forming a meniscus on the surface of the end cap. Keep the SBE 54 in the vertical position for at least 30 minutes before proceeding, to allow any bubbles in the internal plumbing to rise to the surface. Add oil from the small syringe as necessary to maintain the meniscus.
7. Install the supplied capillary fitting (50029) in the pressure port.
 - A. As the fitting is installed, oil should rise the length of the tube and overflow. Wipe up the excess oil with a paper towel.
 - B. Gently tighten the lower portion of the fitting with a 9/16 inch wrench - **DO NOT OVERTIGHTEN**.
 - C. Remove the upper portion of the capillary fitting and tube using a 7/16 inch wrench. Store it for possible use another time.
8. Using the small syringe, add oil to the lower portion of the fitting, forming a meniscus.
9. Fill the large syringe (30521) ¼ full with oil.
 - A. Thread the tube from the pressure bag (30551) through the Swagelock fitting (30002), and install the pressure bag tube over the needle.
 - B. Pull the plunger back on the syringe, drawing a vacuum on the pressure bag until it is completely flat. Maintain the vacuum on the bag.
 - C. Hold the syringe vertically with the bag down and slowly release the plunger, allowing the vacuum to be released. The bag should slowly fill with oil. There is enough oil in the bag when the bag looks like a *small pillow*. It is very important that there are no air bubbles in the pressure bag; you may have to perform this step several times to ensure that there are no bubbles.



10. After the bag is filled, gently remove the tube from the needle, keeping the bag at or below the level of the end of the tube to prevent air from entering the bag. Maintaining gentle pressure on the bag to keep the oil at the end of the tube and prevent air from entering the bag, insert the end of the tube into the lower portion of the fitting on the end cap and screw the Swagelok fitting down, using a 7/16 inch wrench. Oil should overflow from the fitting, preventing air from entering the bag; the overflow should stop when the fitting is tightened. When completed, the bag should be approximately 1/2 full of oil and contain no air.



11. Install the pressure bag in the pressure bag cavity. Place the tubing in the indent, going counter-clockwise from the bag to the fitting.



12. Reinstall the pressure cover, pressure tube guard, and 3 Phillips-head screws, being careful not to pinch the tubing or the bag.

13. Log data on the SBE 54, and download the data. Compare the pressure readings to a local barometer. A pinched or overfilled bag will give pressure readings that are higher than the correct values.

Pressure Sensor Calibration

Note:

After recalibration of the pressure sensor, Sea-Bird enters the new calibration coefficients in the SBE 54 EEPROM, and ships the instrument back to the user with a Calibration Certificate showing the new coefficients.

Sea-Bird sensors are calibrated by subjecting them to known physical conditions and measuring the sensor responses. Coefficients are then computed, which may be used with appropriate algorithms to obtain engineering units. The pressure sensor on the SBE 54 is supplied fully calibrated, with coefficients printed on the Calibration Certificate (in manual).

We recommend that the SBE 54 be returned to Sea-Bird for calibration.

The pressure sensor is capable of meeting the SBE 54 error specification with some allowance for aging and ambient-temperature induced drift.

Note:

Although the pressure sensor manufacturer can re-calibrate the pressure sensor by duplicating the original procedures, the sensor must be removed from the SBE 54, the cost is relatively high, and lead times can be considerable.

The pressure sensor coefficients are entered into the SBE 54 EEPROM with the calibration coefficient commands. The coefficients can be viewed using **GetCD** in Seaterm232. A value for offset (default = 0.0) can be entered in the SBE 54 using the **SetPOffset=** command to make small post-deployment corrections for sensor drift before uploading the data. Techniques are provided below for making small corrections using the slope and offset terms by comparing SBE 54 pressure output to:

- Readings from a barometer
- Readings from a dead-weight pressure generator – provides more accurate results, but requires equipment that may not be readily available

Before using either of these procedures, allow the SBE 54 to equilibrate (with power on) in a reasonably constant temperature environment for at least 5 hours before starting. Pressure sensors exhibit a transient change in their output in response to changes in their environmental temperature. Sea-Bird instruments are constructed to minimize this by thermally decoupling the sensor from the body of the instrument. However, there is still some residual effect; allowing the SBE 54 to equilibrate before starting will provide the most accurate calibration correction.

Calculating Offset using a Barometer

1. Place the SBE 54 in the orientation it will have when deployed.
2. In Seaterm232, connect to the SBE 54.
3. Send **SetSamplePeriod=1** to set up the SBE 54 to take a large number of samples rapidly.
4. Click Capture to save the data to a capture file. Send **Start** to start the test. Send **Stop** to end the test.
5. Compare the SBE 54 output to the reading from a good barometer. Calculate *Offset* = barometer reading – SBE 54 reading.
6. Enter the calculated offset (positive or negative) in Seaterm232 using the **SetPOffset=** command.

Offset Correction Example

Pressure measured by barometer is 1010.50 mbar. Pressure output by SBE 54 is 14.06 psia.

Convert barometer reading to psia using relationship: $\text{mbar} * 0.01 \text{ dbar/mbar} * 1 \text{ psia} / 0.689476 \text{ dbar} = \text{psia}$

Barometer reading = $1010.50 \text{ mbar} * 0.01 / 0.689476 = 14.66 \text{ psia}$ $\text{Offset} = 14.66 - 14.06 = +0.60 \text{ psia}$

Enter offset using **SetPOffset=** command.

Calculating Offset using a Dead-Weight Pressure Generator

To perform this correction:

1. Use a suitable dead-weight pressure generator to subject the sensor to increments of known pressures. The end cap's $5/16$ -24 straight thread permits mechanical connection to a pressure source. Use a fitting that has an o-ring face seal, such as Swagelok-200-1-OR. See *Application Note 12-1: Pressure Port Oil Refill Procedure & Nylon Capillary Fitting Replacement*.
2. In Seaterm232, connect to the SBE 54.
3. Send **SetSamplePeriod=1** to set up the SBE 54 to take a large number of samples rapidly.
4. Click Capture to save the data to a capture file. Send **Start** to start the test. Send **Stop** to end the test.
5. Compare the SBE 54 output at each pressure to the pressure applied by the dead-weight generator.
6. Enter the calculated offset (positive or negative) in Seaterm232 using the **SetPOffset=** command.

Section 5: Troubleshooting

This section reviews common problems in operating the SBE 54, and provides the most common causes and solutions.

Problem 1: Unable to Communicate with SBE 54

The `S>` prompt indicates that communications between the SBE 54 and computer have been established. Before proceeding with troubleshooting, attempt to establish communications again by clicking *Connect* in the Communications menu in Seaterm232 or pressing the Enter key several times.

Cause/Solution 1: The I/O cable connection may be loose. Check the cabling between the SBE 54 and computer for a loose connection.

Cause/Solution 2: The instrument, Comm port, and/or baud rate may not have been entered correctly in Seaterm232. In the Communications menu, select *Configure*, and verify the settings.

Cause/Solution 3: The I/O cable may not be the correct one. The I/O cable supplied with the SBE 54 permits connection to the DB-9P input connector on a standard RS-232 interface.

- SBE 54 Pin 1 (large pin on standard connector) goes to DB-9 pin 5 (ground)
- SBE 54 pin 2 (counter-clockwise from pin 1) goes to DB-9 pin 3
- SBE 54 pin 3 (opposite pin 1) goes to DB-9 pin 2

Cause/Solution 4: In rare cases, the program that controls the SBE 54 microprocessor can be corrupted by a severe static shock or other problem. This program can be initialized by using the reset switch. Proceed as follows to initialize:

1. **As a precaution, upload all data before proceeding.**
2. Open the battery end cap and remove the batteries (see *Replacing Batteries* in *Section 4: Routine Maintenance and Calibration* for details).
3. There is a toggle reset switch on the battery compartment bulkhead, which is visible after the batteries are removed. The switch is used to disconnect the internal back-up lithium batteries from the electronics. Set the switch to the reset position for at least 5 minutes.
4. Reinstall or replace the batteries, and close the battery end cap.
5. Establish communications with the SBE 54 (see *Section 3: Setup, Installation, and Upload* for details). Send the Get Status command (**GetSD**) to verify that the setup is unaffected.

Note:

Using the reset switch does not affect the SBE 54 memory - data in memory and user-programmable parameter values are unaffected.

Problem 2: Nonsense or Unreasonable Data

The symptom of this problem is real-time data or an uploaded file that contains unreasonable values (for example, values that are outside the expected range of the data).

Cause/Solution 1: Data with unreasonable values may be caused by incorrect calibration coefficients in the instrument EEPROM. View the coefficients by sending **GetCD** in Seaterm232. Verify that the calibration coefficients match the instrument Calibration Certificates. If necessary, modify calibration coefficient(s) by sending the appropriate coefficient command(s) (see *Command Descriptions* in *Section 3: Setup, Installation and Upload*). Note that the SBE 54 stores the data in a raw form (i.e., before calibration coefficients are applied). If you have not erased the data from memory, you can enter the correct calibration coefficients in the SBE 54, and then perform an upload again.

Glossary

Note:

All Sea-Bird software listed was designed to work with a computer running Windows XP service pack 2 or later, Windows Vista, or Windows 7.

PCB – Printed Circuit Board.

Seasoft V2– Sea-Bird’s complete Windows software package, which includes software for communication, real-time data acquisition, and data analysis and display. Seasoft V2 includes *SeatermV2*.

SeatermV2 – Windows terminal program *launcher*. Depending on the instrument selected, it launches Seaterm232 (RS-232 instruments), Seaterm485 (RS-485 instruments), or SeatermIM (inductive modem instruments).

Seaterm232 – Windows terminal program used with Sea-Bird instruments that communicate via an RS-232 interface, and that were developed or redesigned in 2006 and later. The common feature of these instruments is the ability to output data in XML.

TCXO – Temperature Compensated Crystal Oscillator.

Appendix I: Command Summary

Note:

See *Command Descriptions* in *Section 3: Setup, Installation, and Upload* for detailed information and examples.

CATEGORY	COMMAND	DESCRIPTION
Status	GetCD	Get and display configuration data.
	GetSD	Get and display status data.
	GetEC	Get and display event counter data.
	GetHD	Get and display hardware data.
Setup - Communication	SetBaudRate=x	x= baud rate for <i>upload</i> (1200, 2400, 4800, 9600, 19200, 33600, 38400, 57600, or 115200). Default 9600. Note: SBE 54 always transmits real-time data at 9600 baud, regardless of this setting.
Setup - General	*Init	Reset SBE 54 to factory defaults.
	SetSamplePeriod=x	x= duration (sec) of each pressure measurement. Range 1 – 240 sec; default 15 sec.
	SetTime=x	x= real-time clock date and time (yyyy – mm-ddThh:mm:ss).
	SetBatteryType=x	x=0: Lithium battery. Default. x=1: Alkaline battery.
Setup – Data Output	SetEnableAlerts=x	x=0: Do not output alerts. x=1: Output alerts. Default.
Sampling	InitLogging	After all data uploaded , send this before starting to sample to make entire memory available for recording. If not sent, data stored after last sample.
	Start	Start sampling now.
	Stop	Stop sampling now.
	SampleRefOsc	Test reference oscillator, taking 1 measurement.
Data Access and Upload	GetSamples:b,x or GS:b,x	Upload x samples, beginning at <i>sample b</i> . Stop sampling (Stop) before sending command. Press Esc or select Command > <i>Abort</i> to cancel.
	GetLastPSamples:x or GLPS:x	Upload last x pressure samples (1 - 1024). Stop sampling (Stop) before sending command. Press Esc or select Command > <i>Abort</i> to cancel.
	GetRSampleList	Upload list of sample numbers of reference samples in memory.
	GetLastRSamples:x or GLRS:x	Upload last x reference oscillator samples (1 - 1024). Stop sampling (Stop) before sending command. Press Esc or select Command > <i>Abort</i> to cancel.
	SetUploadType=x	x=0: Upload in Ascii text in response to UploadData:b,e . x=1: Upload in Binary in response to UploadData:b,e ; twice as fast as Ascii text. Default.
	UploadData:b,e	Upload all raw data in memory from <i>byte b</i> to <i>byte e</i> . Stop sampling (Stop) before sending command. Press Esc or select Command > <i>Abort</i> to cancel.
Diagnostic	ResetEC	Delete all events in event counter.
	TestEeprom	Test EEPROM to verify it is reading and writing correctly.
	TestRefOsc	Test reference oscillator. Test runs until ended by pressing Esc or selecting Command > <i>Abort</i> .

CATEGORY	COMMAND	DESCRIPTION
Calibration Coefficients (F=floating point number) Coefficients are initially factory-set and should agree with Calibration Certificate shipped with SBE 54.	SetAcqOscCalDate=S	S= acquisition crystal calibration date.
	SetFRA0=F	F= acquisition crystal frequency A0.
	SetFRA1=F	F= acquisition crystal frequency A1.
	SetFRA2=F	F= acquisition crystal frequency A2.
	SetFRA3=F	F= acquisition crystal frequency A3.
	SetPressureCalDate=S	S= pressure sensor calibration date.
	SetPressureSerialNum=S	S= pressure sensor serial number.
	SetPRange=F	F= pressure sensor full scale range (psia).
	SetPOffset=F	F= pressure sensor offset (psia).
	SetPU0=F	F= pressure sensor U0.
	SetPY1=F	F= pressure sensor Y1.
	SetPY2=F	F= pressure sensor Y2.
	SetPY3=F	F= pressure sensor Y3.
	SetPC1=F	F= pressure sensor C1.
	SetPC2=F	F= pressure sensor C2.
	SetPC3=F	F= pressure sensor C3.
	SetPD1=F	F= pressure sensor D1.
	SetPD2=F	F= pressure sensor D2.
	SetPT1=F	F= pressure sensor T1.
SetPT2=F	F= pressure sensor T2.	
SetPT3=F	F= pressure sensor T3.	
SetPT4=F	F= pressure sensor T4.	

Appendix II: Data Formats

This appendix provides detailed information on data format for each file type.

Extension	Description
.cap	Capture file of real-time data from SBE 54.
.xml	Data uploaded from SBE 54 memory using Seaterm232.

Real-Time Data Format (.cap extension)

Notes:

- Each pressure measurement record displays **after** the pressure integration for that period is complete.
- The date and time correspond to the time at the **completion** of the pressure measurement.
- Contact Sea-Bird for information on using the reference frequency data to correct uploaded data for reference oscillator long-term drift.

Real-time output is saved to a .cap file if you click Capture in Seaterm232.

Each time a pressure measurement is completed, the real-time data is displayed. SBE 54 outputs data in this order: sample number, date and time, pressure (psi), and pressure sensor temperature (°C). An example output is provided below:

```
<Sample Num='501' Type='Pressure'>
<Time>2006-09-06T10:54:31</Time>
<PressurePSI>16.9351</PressurePSI>
<PTemp>22.4224</PTemp>
</Sample>
```


.XML Data Format (.xml extension)

A .xml file contains data uploaded from SBE 54 memory using Seaterm232's Upload menu. The beginning of a sample .xml file follows:

```
<?xml version="1.0"?>
<!-- SCPlusV2_RS232 -->
<SBEDataUploadFile>
<ApplicationData>
<Seaterm232>
<SoftwareVersion>1.00d</SoftwareVersion>
<BuildDate>21-Aug-2008</BuildDate>
</Seaterm232>
</ApplicationData>
<InstrumentState>
<HardwareData DeviceType='SBE54' SerialNumber='00000003'>
<Manufacturer>Sea-Bird Electronics, Inc</Manufacturer>
<FirmwareVersion>SBE54 V1.2-6MHZ</FirmwareVersion>
<FirmwareDate>Jan 31 2007</FirmwareDate>
<HardwareVersion>41477A</HardwareVersion>
<HardwareVersion>41478A</HardwareVersion>
<PCBSerialNum>NOT SET</PCBSerialNum>
<PCBSerialNum>NOT SET</PCBSerialNum>
<PCBType>1</PCBType>
<MfgDate>29-Jan-07</MfgDate>
</HardwareData>
<StatusData DeviceType='SBE54' SerialNumber='00000003'>
<DateTime>2007-03-12T11:14:17</DateTime>
<EventSummary numEvents='0' />
<Power>
<MainSupplyVoltage>17.6</MainSupplyVoltage>
</Power>
<MemorySummary>
<Samples>16816</Samples>
<Bytes>253440</Bytes>
<BytesFree>133964288</BytesFree>
</MemorySummary>
</StatusData>
<ConfigurationData DeviceType='SBE54' SerialNumber='00000003'>
<CalibrationCoefficients>
<AcqOscCalDate>NOT SET </AcqOscCalDate>
<FRA0>5.999905E+06</FRA0>
. . . (more pressure sensor calibration coefficients)
</CalibrationCoefficients>
<Settings batteryType='0' baudRate='115200' enableAlerts='1'
uploadType='0' samplePeriod='15' />
</ConfigurationData>
</InstrumentState>
<InstrumentRawData>
<SBEDataUpload startAddr='0'>
<Type>1</Type>
<DataFormat>PRESSUREHEX0</DataFormat>
<Bytes>100000</Bytes>
<Data>
010000002B19840D094125365D059207
2BA95D05C0098D131700B82921009142
27C5FFFFFFFF084125365D059207461C
. . . (more pressure data)
```

Looking at lines in the file:

- Beginning lines - Header lines contain (in order):
 - Software version used to upload the data
 - SBE 54 response to Get Hardware Data (**GetHD**) command
 - SBE 54 response to Get Status Data (**GetSD**) command
 - SBE 54 response to Get Configuration Data (**GetCD**) command
- Following lines - Data follows, with each line followed by a carriage return and line feed.

Pressure Data Format (.txt extension)

Seaterm232's Convert utility (Tools menu, *Convert .XML data file*) creates a .txt file with the pressure data from the uploaded .xml file. If you select **raw instrument data** for the output pressure samples, the output column headings are as follows:

Column Heading	SampleNum	Time	Thermistor	HFPCount	LFPCount	HFPTCount	LFPTCount
Description	Sample number	Time (sec) since January 1, 2000	PCB temperature raw thermistor value	Acquisition oscillator transition count for pressure signal	Pressure sensor transition count	Acquisition oscillator transition count for pressure temperature signal	Pressure temperature transition count

Reference Oscillator Data Format (.txt extension)

Seaterm232's Convert utility (Tools menu, *Convert .XML data file*) creates a .txt file with the reference oscillator data from the uploaded .xml file. The reference oscillator data can be used to correct the pressure data for long-term drift of the pressure sensor (expected to be on the order of 1 ppm per year). **Sea-Bird does not currently supply software to do this correction.** The column headings for the **reference oscillator** output file are as follows:

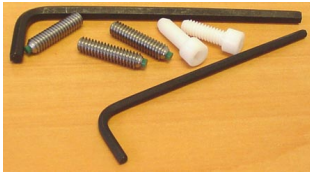
Column Heading	SampleNum	Time	Thermistor	HFPTCount	LFPTCount	HFPCount	LFPCount
Description	Sample number	Time (sec) since January 1, 2000	PCB temperature raw thermistor value	Not applicable – set to 0	Not applicable – set to 0	Acquisition oscillator transition count for reference oscillator measurement	Reference oscillator divider transition count

Making Corrections Using Reference Oscillator Data

You can use the reference frequency data in the pressure scans and in the reference frequency scans to correct uploaded data for pressure sensor acquisition frequency drift. Contact Sea-Bird for instructions.

Appendix III: Electronics Disassembly/Reassembly

Jackscrew
kit



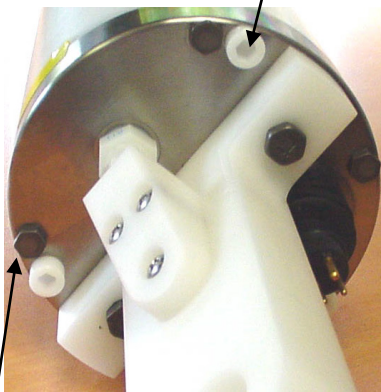
Sea-Bird provides a jackscrew kit with the SBE 54, to assist in removal of the connector end cap. The kit contains:

- 2 Allen wrenches
- 3 jackscrews
- 2 spare plastic socket hex-head screws

Disassembly

1. Establish communications with the SBE 54 (see *Section 3: Setup, Installation, and Upload* for details). **As a precaution, click Upload to upload any data in memory before beginning.**
2. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
3. Remove the four titanium hex-head screws securing the connector end cap to the housing.
4. Remove the three plastic hex-head screws from the end cap using the larger Allen wrench. Insert the three jackscrews in these three holes in the end cap. When you begin to feel resistance, use the smaller Allen wrench to continue turning the screws. Turn each screw 1/2 turn at a time. As you turn the jackscrews, the end cap will push away from the housing. When the end cap is loosened, pull it and the PCB assembly out of the housing.
5. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue. Be careful to protect the O-rings from damage or contamination.
6. Disconnect the Molex connector connecting the PCB assembly to the battery compartment bulkhead.
7. Remove the jackscrews from the end cap.

Plastic hex-head screw
(typical, 3 places)



Titanium hex-head screw
(typical, 4 places)

Reassembly

Note:

Before delivery, a desiccant package is inserted in the housing and the electronics chamber is filled with dry Argon gas. These measures help prevent condensation. To ensure proper functioning:

1. Install a new desiccant bag each time you open the electronics chamber. If a new bag is not available, see *Application Note 71: Desiccant Use and Regeneration (drying)*.
2. If possible, dry gas backfill each time you open the housing. If you cannot, wait at least 24 hours before redeploying, to allow the desiccant to remove any moisture from the housing.

Note that opening the battery compartment does not affect desiccation of the electronics.

1. Remove any water from the O-ring and mating surfaces with a lint-free cloth or tissue. Inspect the O-ring and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-ring and mating surfaces.
2. Reconnect the Molex connector to the PCB assembly. Verify the connector holds and pins are properly aligned.
3. Carefully fit the PCB assembly into the housing, aligning the holes in the end cap and housing.
4. Reinstall the 4 hex-head screws to secure the end cap to the housing.
5. Reinstall the 3 plastic hex head screws in the end cap.
6. Establish communications with the SBE 54 (see *Section 3: Setup, Installation, and Upload* for details). Reset the date and time (**SetTime=**) and initialize logging (**InitLogging**) before redeploying. No other parameters should have been affected by electronics disassembly (send **GetCD** to verify).

Appendix IV: Pressure-to-Depth Conversion

Force is mass * acceleration, units are Newtons [N]:

$$N = \text{Kg m} / \text{sec}^2$$

Density (ρ) is mass / volume, units are [Kg / m^3]:

This is the *in situ* value, and is approximately $1025 \text{ Kg} / \text{m}^3$ at the surface.

Specific weight (W) is weight / volume, units are [N / m^3]:

$$W = \rho * g$$

where g = local gravity [m / sec^2]

Hydrostatic equation:

$$p = p_{\text{atm}} + W * z$$

p_{atm} = atmospheric pressure in Pascals [N / m^2]

p = total pressure in Pascals [N / m^2]

W is average density times gravity [N / m^3]

z = depth [m]

Conversions:

$$1 \text{ Pascal} = 10^{-4} \text{ decibars}$$

$$1 \text{ psi} = 0.6894757 \text{ decibars}$$

Example:

$$\text{average density} = 1025 \text{ kg} / \text{m}^3$$

$$\text{average gravity} = 9.8 \text{ m} / \text{sec}^2$$

$$\text{pressure reading} = 6000 \text{ decibars} = 6 \times 10^7 \text{ Pascals}$$

$$\text{atmospheric pressure} = 14.7 \text{ psia} = 1.013529 \times 10^5 \text{ Pascals}$$

$$W = 1025 * 9.8 = 10045 \text{ [N} / \text{m}^3]$$

$$6 \times 10^7 - 1.013529 \times 10^5 = 10045 * z$$

$$z = 5.989865 \times 10^7 / 10045 = 5963.031 \text{ meters}$$

Appendix V: Replacement Parts

Part Number	Part	Application Description	Quantity in 54
22018	Alkaline D-cell batteries, Duracell MN1300 (LR20)	Power 54	12
41124A	Battery cover plate	Retains alkaline D-cell batteries	1
801575	Battery cover plate/spacer	Retains lithium DD-cell batteries with buttons	-
30346	Screw, 10-24 x 1" hex-head, titanium	Secures connector end cap to optional titanium housing	4
50092	SBE 16/19 Jackscrew Kit	For removing connector end cap	1
60021	Spare battery end cap hardware and o-rings	O-rings and hardware, including: <ul style="list-style-type: none"> • 30145 Screw, 6-32 x 1/2" Phillips-head, stainless steel (secures battery cover plate to battery posts) • 30242 Washer, #6 flat, stainless steel (for screw 30145) • 30816 Parker 2-234E603-70 (battery end cap to housing piston seal) • 30090 Parker 2-153N674-70 (battery end cap to housing face seal) 	-
50056	Spare parts kit	Assorted hardware and o-rings, including: <ul style="list-style-type: none"> • 30145 Screw, 6-32 x 1/2" Phillips-head, stainless steel (secures battery cover plate to battery posts) • 30242 Washer, #6 flat, stainless steel (for screw 30145) • 30447 Bolt 1/4-20 x 1 1/4 Hex, titanium (secures life eye to connector end cap and plastic bar to battery end cap) • 30816 Parker 2-234E603-70 (battery end cap to housing piston seal) • 30090 Parker 2-153N674-70 (battery end cap to housing face seal) • 30815 Parker 2-233E603-70 (connector end cap to housing radial piston seal) 	-

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Part Number	Part	Application Description	Quantity in 54
801225	4-pin RMG-4FS to DB-9S data I/O cable, 2.4 m (8 ft) long	From SBE 54 to computer	1
801374	4-pin MCIL-4FS (wet-pluggable connector) to DB-9S data I/O cable, 2.4 m (8 ft) long	From SBE 54 to computer	1
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	-
17043	Locking sleeve	Locks I/O cable or dummy plug in place	2
171192	Locking sleeve (wet-pluggable connector)	Locks I/O cable or dummy plug in place	2
17046.1	4-pin RMG-4FS dummy plug with locking sleeve	For I/O connector during storage	1
171398.1	4-pin MCDC-4-F (wet-pluggable) dummy plug with locking sleeve	For I/O connector during storage	1

Appendix VI: Manual Revision History

Manual Version	Date	Description
002	03/07	<ul style="list-style-type: none"> Initial production release.
003	03/07	<ul style="list-style-type: none"> Firmware 1.3: Add ability to program sample period from 1–240 sec.
004	11/08	<ul style="list-style-type: none"> Update for SeatermV2 terminal program. Maintenance: “Mated connectors do not require periodic disassembly or other attention” was inconsistent with application note 57; revised.
005	02/10	<ul style="list-style-type: none"> Update SBE address. Add CE mark. Change Seasoft-Win32 to Seasoft V2, update .exe file name to SeasoftV2_date.exe Update SeatermV2 screen capture.
006	01/13	<ul style="list-style-type: none"> Correct order of output for Reference Oscillator Data Format in Appendix II. Add information on high baud rate limitations, and disabling of automatic time setting tools in Seaterm232 if baud is set to 115200. Add cable and wiring diagrams. Update software compatibility information. Add Declaration of Conformity.
007	05/13	<ul style="list-style-type: none"> Add dimension for externally powered SBE 54. Remove plastic housing option. Update SeatermV2 screen capture; add Serial Port Config dialog screen capture.

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