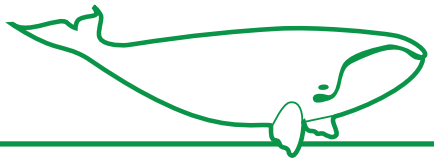
BIOACOUSTIC PROBE USER'S MANUAL

Model B002B

Firmware version 1.5.3, BProber version 1.7.3
January 2008



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Model B002B

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CONTENTS

1 DO'S AND DON'TS

DO set your Palm PDA time correctly before commanding the Bioacoustic Probe.

DO bring your PDA's charging and PC-communication gear with you to the field.

DO consider bringing a spare backup PDA, preloaded with the BProber software, to the field.

DO, before each deployment, swab the positive battery contact (at the deep end of the battery housing) and the contact surfaces on the battery with isopropyl alcohol and allow to dry.

If your B-Probe has a press-fit positive battery spring insert (all A-series, and B-series numbers 025 and before) **DO** also remove the battery spring insert and clean the screw head and the underside of the battery spring as well; **DO** consider applying silicone grease or contact enhancer (such as Stabilant 22) to the screw head after cleaning, to retard oxidization.

DO inspect the o-rings and o-ring seats (both on the battery cap and the battery enclosure) for cuts, abrasions, contamination, and adequate lubrication before each deployment.

DO use the Saft LS 14250 battery (NOT the LST 14250 or LS 14250C).

DO use fresh, recently manufactured batteries that you have tested.

DO tighten the battery cap **securely** to avoid vibration-induced power failure.

DO save the Probe's text log after deployments for future reference.

DO consider turning auxiliary sampling off when sampling acoustics at rates above 10159 Hz.

DO learn about common problems from the troubleshooting tips at the end of this manual.

DON'T drop the B-Probe or its battery cap when the cap has been removed.

DON'T force the battery cap if it will not "bottom" when being screwed on by hand.

DON'T use a metal object, such as a knife or metal tweezers, to remove the o-rings.

DON'T use petroleum-based lubricants (e.g. Vaseline) on the o-rings.

DON'T allow alcohol to come in contact with the polyurethane body of the B-Probe.

DON'T secure the B-Probe tightly around the pressure transducer (silver disk visible through polyurethane) or the hydrophone (middle area of tag).

DON'T subject the B-Probe to pressures more than 125% of its pressure-sensor's rating (sensor limits are available via the **CALIBRATE** page in **BProber**). For extremely sensitive sensors, finger pressure alone may be enough to destroy the sensor.

DON'T attempt to load new firmware without being advised to do so by the manufacturer.

DON'T allow the lithium battery to become shorted, by salt water or anything else.

DON'T store lithium batteries in heat or humidity.

DON'T expect the acoustic-sampling LED flash to occur precisely at the top of the minute; it may be delayed by several seconds due to the higher priority given to acoustic sampling.

DON'T erase storage, upload new firmware, or download large amounts of data while running on battery. Use shore power instead.

2 HANDLING AND ATTACHING THE BIOACOUSTIC PROBE

The Bioacoustic Probe consists of a single electronics board encapsulated in a polyurethane resin. Use Figure 1 to orient yourself to the Probe's mechanical aspects.

The B-Probe is designed to require very little mechanical attention. Except for the battery housing, no wires or other parts penetrate the polyurethane encapsulant. Nevertheless, use of the Bioacoustic Probe requires appropriate use and care of the battery housing, magnetic switch, and infrared port.

2.1 BATTERY SPECIFICATION AND INSTALLATION

The only battery specified to work in the Bioacoustic Probe is the Saft LS 14250, a 3.6-V 1/2-AA size lithium cell (the Saft LST 14250 and LS 14250C have lower current capability and should be avoided for this application). The battery is inserted with the positive "button" in first and the negative, smooth end exposed to contact the enclosure-cap spring.

If a dead or nearly dead battery is inserted, the Probe will either fail to operate at all, or may flash the system LED briefly and inconsistently, or, about 15–25 seconds after insertion of the battery, will begin rapidly to flash its bright red LED in a continuing series of bursts.

If the battery is inserted backwards by mistake, Probe models B002B and later will light a bright yellow LED.

Caution: As with all battery-operated equipment, it is best to remove the battery when it appears that the battery will not be necessary for an extended period. Battery leakage could damage the Probe.

WARNING: ON EARLY MODEL B002A (2002) BIOACOUSTIC PROBES, INSERTING THE BATTERY INCORRECTLY WILL DESTROY THE BIOACOUSTIC PROBE AND CREATE A POTENTIAL EXPLOSION HAZARD. Improper battery insertion will not damage Model B002B (2003) Bioacoustic Probes.

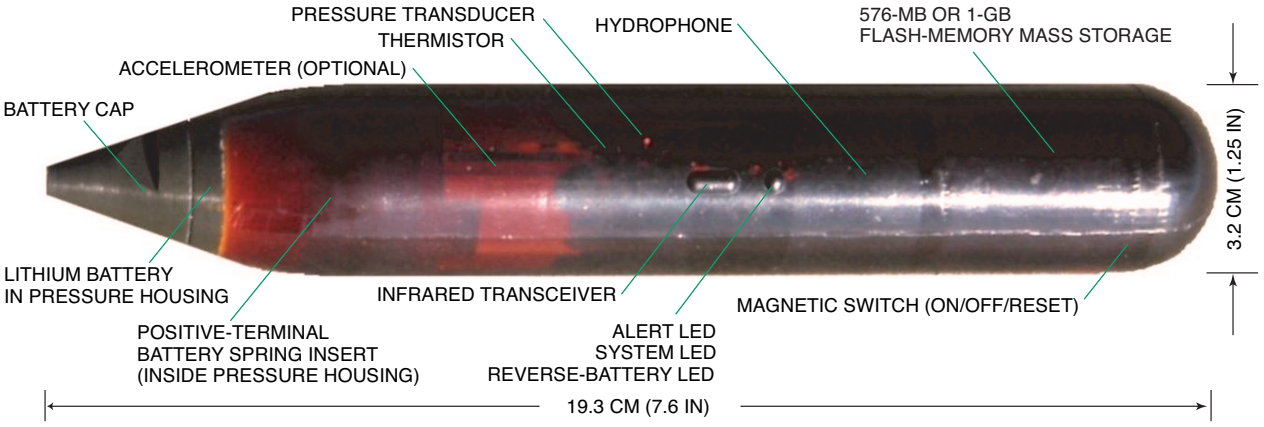

Figure 1. Model B002B Bioacoustic Probe.

2.2 CARING FOR THE BATTERY COMPARTMENT AND CAP

After retrieving a Probe from the field, rinse it with fresh water before unsealing the battery cap. This will discourage intrusion of salt water or other contaminants into the battery compartment when you open it.

2.2.1 O-rings

Before resealing the battery cap, examine the o-ring or o-rings closely for wear, contaminants, or damage. Be certain the o-ring seats are smooth and clean, both on the enclosure cap and the enclosure itself. The o-rings should be greased lightly, with just enough grease to ensure smooth movement when the cap is screwed back on, and proper sealing deformation when under pressure. More grease than this is not necessary and will attract contaminants. Adding a slight amount of the same grease to the threads of the enclosure cap will smooth mating of the cap to the enclosure.

Contaminated o-rings and seats may be cleaned by removing the o-rings, wiping the o-rings and seats with isopropyl alcohol, and re-greasing. ***Caution: If alcohol comes in contact with the polyurethane encapsulant wipe it off immediately. Alcohol will damage the polyurethane.*** Be careful not to cut or abrade o-rings while slipping them over the sharp threads of the enclosure cap. Replace o-rings found to be worn or damaged. O-rings have a limited life span, especially when stored compressed with the battery cap screwed on.

WARNING: NEVER use Vaseline, WD-40, or any other petroleum-based lubricant on o-rings. Petroleum products can damage o-rings and result in failure. Use only a high grade silicone valve lubricant/sealant such as Dow Corning 111.

WARNING: NEVER use any metal object to pry o-rings out of their seats! Knife blades, tweezers, paper clips, and the like may damage the o-rings or, worse, their aluminum seats. Damage to the o-ring seats greatly increases the likelihood of failure when under pressure, potentially causing permanent damage to the B-Probe.

2.2.2 Battery contacts

Periodically – especially with Bioacoustic Probes serial numbers 025 and before – it is necessary to clean the positive-terminal battery contacts. Dirty or oxidized contacts will increase resistance in the power supply, increasing the probability of premature power failure.

For serial numbers 025 and before, clean the insert by removing it using needlenose pliers – taking great care not excessively to bend the insert's spring-metal contacts or to compromise the insert's nickel plating – and swabbing its metal surfaces gently with isopropyl alcohol. It is also most important to swab the positive battery terminal screw head (located inside the battery housing and revealed when the battery-spring insert is removed). This screw is made of stainless steel and tarnishes with time and exposure to a marine environment. After swabbing the screw head, consider applying silicone grease or a contact enhancer to the screw head to minimize future oxidation.

For serial numbers 026 and after, the positive-terminal battery spring is screwed into the positive battery post and need not be removed. Be sure nevertheless that the battery-contact surface of the insert is clean. Sealing with grease is not necessary, although contact enhancer may improve performance.

2.2.3 Securing the battery cap

Secure the battery cap carefully to be certain the o-rings seat properly. It is possible for poorly seated o-rings to bind out of their seats as the cap is screwed in.

Be certain to screw the enclosure cap on tightly. In models whose enclosure cap is equipped with flats (for example the unit shown in Figure 1), use a wrench to tighten the cap after you have "bottomed" it by hand. If the enclosure cap is not completely secure, tiny movements of the cap may interrupt power to the electronics, causing data acquisition to cease.

Caution: If you cannot "bottom" the enclosure cap while turning it by hand, STOP and do NOT attempt to finish screwing in the cap using a wrench. If the enclosure cap does not "bottom" by hand, it indicates that foreign material is contaminating the threads, that the o-rings have been pinched, or that the enclosure or cap have been damaged. Remove the cap and inspect the threads and o-rings for damage or contamination.

WARNING: NEVER drop the instrument or the battery cap when the two are separated! When separate, both cap and enclosure are easily damaged by impacts. If the battery compartment or cap are deformed, they will not seal, and the instrument cannot be used underwater.

2.3 LED

The Bioacoustic Probe model B002B has three LED indicators – a bright red LED, a dimmer yellow (orange in earlier units) LED, and a bright yellow LED – all clustered together under a raised circular bump on the side of the resin encapsulation. The bright red *alert LED* acknowledges commands, indicates error conditions, and double-flashes once a minute when the Probe awaits instructions in **STANDBY** mode. The yellow/orange *system LED* lights when the Probe first turns on and flashes intermittently during long operations, such as data sampling, directory rebuilding, and infrared data transfer. The bright yellow LED only lights when the battery has been inserted backwards; it does not light during normal operation. **WARNING: IF YOU ARE USING ONE OF THE SIX EXISTING MODEL B002A (2002) BIOACOUSTIC PROBES, DO NOT INSERT THE BATTERY BACKWARDS. YOU WILL DESTROY THE INSTRUMENT.**

When an LED flashes, the flash rate indicates the nature of the alert. Slow flashing with a period of 1 s (a "note alert") indicates that an operation has completed successfully. An extremely rapid flash rate ("stop alert") signals an error condition, such as a low battery. A moderate flash rate ("caution alert") indicates that an activity has begun or is in progress.

2.4 MAGNETIC RESET AND TURN-OFF SWITCH

The Bioacoustic Probe is equipped with a magnetically-operated switch near its front end (see Figure 1). The switch is marked by a patch of white paint clearly visible through the polyurethane resin. Operating this switch by holding a sufficiently strong magnet close will reset the processor, equivalent to a "restart" or "reboot" command on a personal computer. The instant the switch "sees" the magnet, the Probe will light the system LED and begin its restart. Once the system LED lights, the magnet may be removed.

One may also use the magnetic switch to turn off the Probe. Move the magnet close, as described above, until the system LED lights. At this point, STOP moving the magnet and leave it in place. The system LED will remain lit for a few seconds, then go out. At this point the Probe is turned off, and will remain turned off as long as the magnet remains in the same place. You will need to tape the magnet in this location to ensure the B-Probe remains off. If the magnet is moved away from the position where it triggered the magnetic switch, the B-Probe may turn on again.

Caution: The Bioacoustic Probe can NOT be programmed to begin sampling when the magnet is removed. When the magnet is removed, the Probe reboots and enters* STANDBY*. Leaving a magnet taped to the Probe is only for the purpose of turning the Probe completely* OFF *without having to remove the battery.

2.5 POWER ADAPTER

Downloading and erasing data from the Bioacoustic Probe demand significant power. To preserve battery life, use the custom power adapter to connect the B-Probe to "shore power" while erasing or downloading data. The power adapter must also be used when performing software or filesystem maintenance, for example, when uploading new firmware or reformatting the mass-storage unit.

2.6 ATTACHING THE BIOACOUSTIC PROBE

While the method used to attach the Bioacoustic Probe will depend on the application, a few guidelines apply to all attachment techniques.

Do not secure around the hydrophone

The hydrophone is located in the center of the B-Probe (see Figure 1). It begins at a location about 0.5 cm "aft" (towards the battery enclosure) of the aft end of the infrared port, and extends from there about 4 cm "forward" (away from the battery enclosure). Attaching the instrument by cinching hose clamps or cable ties tightly around the hydrophone may reduce the hydrophone's sensitivity, change its frequency response, or damage it, or may introduce unwanted local noise.

It is better not to secure directly over the pressure transducer

The pressure transducer is visible through the polyurethane as a small silver disk located between the LEDs and the battery enclosure on the side opposite from the magnetic switch. While it is unlikely that cinching the B-Probe at the pressure transducer will damage deep-rated pressure transducers, it will introduce an unwanted offset on the pressure record. Shallow-rated pressure transducers are very fragile and may be destroyed, or at least saturated, if exposed directly to cinched straps or ties.

Avoid local sources of acoustic noise

An attachment system that creaks, bumps, or oscillates is guaranteed to introduce unwanted noise in the acoustic record. The noise may be strong enough to saturate the electronics, rendering the acoustic record unusable.

Consider flow-noise effects

When the B-Probe is moving through the water, flow noise is unavoidable; however, care in the attachment design can significantly reduce the impact of flow noise.

3 SUPPORT EQUIPMENT

You will need separate equipment to operate the Bioacoustic Probe and retrieve acquired data. Your equipment must meet this minimum configuration.

3.1 PERSONAL DIGITAL ASSISTANT

You need an infrared-equipped Personal Digital Assistant (PDA) that runs version 3.5 or later of the Palm Operating System (PalmOS). New Palm-compatible PDAs are available from Palm One. Used Palm-compatible PDAs from Handspring and Sony should also work. You will need to learn how to operate your PDA, especially how to load new applications by synchronizing the PDA with your personal computer. You also must be able to enter alphanumeric characters using either the PDA's keyboard mode or its handwriting recognition system.

3.2 PERSONAL COMPUTER

Your personal computer (PC) must be compatible with your choice of PDA.

Your PC must be able to operate an Infrared Developer's Association (IrDA) port at Standard Infrared (SIR) speeds or better. Notebook computers with built-in infrared ports and running Windows 2000 or Windows XP have been found compatible with the Bioacoustic Probe. The Bioacoustic Probe was developed using Apple Macintosh computers running OS X 10.1.4 or better; these computers are fully compatible, provided they have an available USB port to attach an external infrared adaptor.

Because you will be downloading and organizing large data files on your PC, it will be very helpful if the PC has at least 5 GB of disk storage available. Some means of archiving large data sets, such as an internal or external CD-R burner, is essential.

Caution: PC-compatible notebook computers equipped with an infrared port generally disable that port by default. If you wish to use a PC-compatible notebook to download data via infrared, you may need explicitly to enable the infrared port (sometimes labeled "IRDA") in the BIOS. BIOS setup commands differ substantially between PC's; consult the manual for your model of PC.

3.3 INFRARED COMMUNICATION EQUIPMENT

If you wish to use an Apple Macintosh computer, or a Windows 2000 or XP computer without a built-in infrared port, you will need to obtain an external infrared adaptor. For Windows systems, this adaptor must be compatible with Windows. For OS-X-based systems, you will need to run communication software provided by Greeneridge. **This software is at present only compatible with the Actisys ACT-IR220Lplus infrared adaptor** (www.actisys.com, 510-490-8024). PC's that have USB but not serial ports (e.g. all newer Macintosh computers) will also require a USB-to-serial adaptor. While a variety of USB-to-serial adaptors may work to mate the infrared unit to the PC's USB port, we recommend the **Keyspan USA-19HS** (or

its predecessor the **USA-19QW**) high-speed serial adaptor, carried by most Mac/PC catalog houses.

At present OS X lacks native support for the IrOBEX infrared object exchange protocol used by the Bioacoustic Probe. Therefore even Macintosh computers equipped with built-in infrared ports still require the external infrared adaptor described above.

Note that to use the Keyspan adaptor, you will need to install the appropriate drivers on your personal computer.

3.4 SMALL TOOLS AND SUPPLIES

Field operation of the Bioacoustic Probe will require the following tools and supplies:

- Easily handled magnet – a thick refrigerator magnet may do
- Silicone valve lubricant and sealant (e.g. Dow Corning 111)
- Wrench (1/2" open-end, for use with tapered battery caps)
- Spare o-rings (Mag Instrument 108-000-042). Note that the Mag Instrument o-ring may be obtained in a pinch from the lens end (NOT the battery-cap end) of a Mini-Maglite (two AA battery) flashlight.
- Batteries (Saft LS 14250 – NOT LST 14250 or LS 14250C! – 3.6V 1/2-AA lithium)

4 OPERATIONAL MODES

The Bioacoustic Probe operates in eleven modes. This section describes how one interacts with the Probe in each mode.

4.1 OFF

OFF allows the Probe to be placed in an extreme-low-power mode without removing the battery. When a sufficiently strong magnet is mechanically held in the reset location, the Probe, after a few seconds of being held in **RESET**, will turn **OFF**. In this mode the Probe draws approximately 6 μA current. This level of power drain is nearly negligible; for example after thirty days **OFF**, a 400-mAh battery will have lost approximately 1% of its energy.

In **OFF** mode the LED is not lit, and the Probe does not listen to infrared transmissions. To leave **OFF** mode, remove the magnet.

4.2 RESET

A few seconds after power is first applied to the Probe, or the magnet has been removed to allow the Probe to leave **OFF** mode, the Probe enters **RESET** mode.

RESET is a transient mode that exists only when the central processing unit (CPU) of the Probe is electrically held in reset. A healthy Probe will never remain in **RESET** longer than two seconds, after which it will transition to **BOOT** mode. If the Probe remains in **RESET** longer than two seconds, as evidenced by the system LED remaining continuously on, it is damaged. Remove the battery or power source immediately.

During **RESET** the system LED is solidly lit.

4.3 BOOT

BOOT mode is the transient mode that occurs immediately after **RESET**. During **BOOT**, the Probe loads software from its mass-storage unit into main memory, a process that requires approximately 26 seconds. When loading completes successfully, the alert LED will triple-flash.

If the Probe is unable to load its software properly during **BOOT**, it will flash the alert LED rapidly and enter **COMA** until reset. If the cause of boot failure is insufficient power, a burst of rapid LED flashes will be repeated several times before the Probe enters **COMA**. This indicates either that the battery needs to be replaced, or that the positive battery terminal contacts are dirty. See Section 2.2 for instructions on cleaning the battery contacts.

If the Probe detects an infrared transmission during the first three seconds of **BOOT**, it attempts to load software into memory directly from the infrared transmission rather than from mass storage. This process is called an *infrared boot*. Infrared-booting is only necessary when the Probe's operating system has been erased or corrupted, or when it is necessary to update the bootcode. Do not attempt to infrared-boot the Probe unless advised to do so.

During the **BOOT** operation the alert LED flashes only to signify the completion of normal (triple-flash) or abnormal (rapid multiple flashes) loading of the Probe software.

If the alert LED does not flash at all in **BOOT**, it indicates that the Probe has dramatically insufficient power or that its boot code has been corrupted. In the latter case the Probe may have to be returned to the manufacturer for repair.

Note that each **BOOT** operation consumes approximately 1.5% of the total energy of a 400-mAh battery. To preserve the maximum amount of battery life for data acquisition, do not reset or power-cycle the Probe more than necessary.

4.4 REBUILD

After the Probe has completed **BOOT**, it enters **REBUILD**, another transient mode.

In **REBUILD** mode, the Probe analyzes data contained in its mass-storage unit and reconstructs filesystem directory indices based on the information it finds. **REBUILD** may last up to two minutes depending on the amount of data stored. If the storage unit is empty the Probe will immediately continue to **STANDBY** mode. Infrared transmissions are ignored during **REBUILD**.

While in **REBUILD**, the system LED flashes briefly for every 8 MB of data inspected.

4.5 STANDBY

Once the Probe has booted properly and rebuilt its filesystem indices, it enters **STANDBY** mode. In this mode the Probe listens for infrared transmissions and acts upon them. While in **STANDBY** the Probe draws an approximate 400 μA current. This translates to an energy loss of 2.5% of a 400 mAh battery for each day of standby.

To signify operation in **STANDBY** mode, the Probe double-flashes the alert LED once per minute. The double-flash takes place at the top of the minute according to the Probe's internal clock.

4.6 DOZE

In **DOZE**, the Probe is "taking a break" between operations. This usually occurs when the Probe has been asked to sample acoustics on an intermittent schedule; between these acoustic sampling "windows" the Probe returns to the low-power **DOZE** state. During **DOZE** mode, the infrared transceiver is monitored for user communications.

The LEDs remain unlit throughout **DOZE** mode, even if auxiliary channels are being sampled in a hiatus between scheduled acoustic sampling intervals.

4.7 COMA

COMA mode is only entered when a fatal condition has occurred, such as a discharged battery or a software error. If possible, the Probe will attempt to alert the user that it has entered **COMA**, either by rapidly flashing the alert LED or by making an entry in the log file for later inspection. The only way to exit **COMA** is by resetting or power-cycling the Probe.

4.8 SAMPLING

In **SAMPLING** mode the Probe is actively acquiring data. The Probe enters **SAMPLING** mode when commanded to do so, either immediately or at a user-preset "delayed start" time.

The Probe contains two separate data acquisition systems: a primary channel for high-sampling-rate acoustic data and auxiliary channels for slower data such as temperature and pressure. In **SAMPLING** mode auxiliary sampling is always taking place (unless the user has disabled it), and primary sampling may or may not be taking place.

While **SAMPLING** acoustics, the system LED flashes once, very briefly, near the top of each minute. Unlike **STANDBY**, in **SAMPLING** the LED flash may not coincide precisely with the internal clock; this is due to the lower priority given to the LED while **SAMPLING**.

When **SAMPLING** on a duty cycle, the system LED will flash ONLY during the "on" part of the cycle, when acoustics are being sampled. During the "off" part of the cycle the system LED will not flash, although auxiliary channels continue to be sampled.

4.9 DOWNLOAD

When requested to send data, log, calibration or directory files to an infrared recipient, the Probe enters **DOWNLOAD** mode.

While downloading files, the system LED flashes once for each kilobyte transferred.

4.10 UPLOAD

Only two kinds of files may be uploaded to the Probe: calibration files and new firmware. Any other type of file will be ignored although it may appear to be accepted.

The Bioacoustic Probe is case-sensitive. When uploading a file, be certain its filename precisely matches the required format for that file.

4.11 ERASE

The B-Probe never overwrites acquired data. Only an explicit **ERASE** request from the PDA will remove data from the storage unit. **ERASE** erases all data on the storage unit, and can take several minutes to complete, depending on the storage capacity.

During **ERASE**, the alert LED flashes for every 128 megabytes of storage erased. If a PDA is in infrared range when the LED flashes, a percent-completed status report will be transmitted to the PDA. Infrared transmissions from the PDA to the B-Probe during **ERASE** will have no effect.

5 USING THE PDA

Once the battery is inserted, all interaction with the Bioacoustic Probe takes place through its infrared interface with a personal digital assistant (PDA) running the Palm Operating System (PalmOS). The PDA must have been loaded with custom commanding software called **BProber**. See your PDA instructions to transfer the **BProber.PRC** software file to your PDA.

The most important thing to remember about your PDA is that you **must set its date and time correctly. BProber** obtains the date and time from the PalmOS and provides them automatically to the Bioacoustic Probe during infrared communications. If your PDA has not been set to the correct date and time, all your data files will be timestamped incorrectly.

This version of the manual does not cover all the capabilities of **BProber**. Future manuals will describe operation of **BProber** in greater detail.

5.1 NAVIGATING BPROBER

The **BProber** software consists of several "pages" that allow interaction with the B-Probe in different topics. One accesses the different pages using the menu selector; Figure 2 shows the drop-down menu that appears when the program menu is requested by pressing your PDA's menu icon.

The concept of operating BProber is simple: you use the PDA to send an infrared information or request packet to the B-Probe, and the B-Probe responds. In most cases the B-Probe's response will include sending an infrared data or confirmation packet back to the PDA.

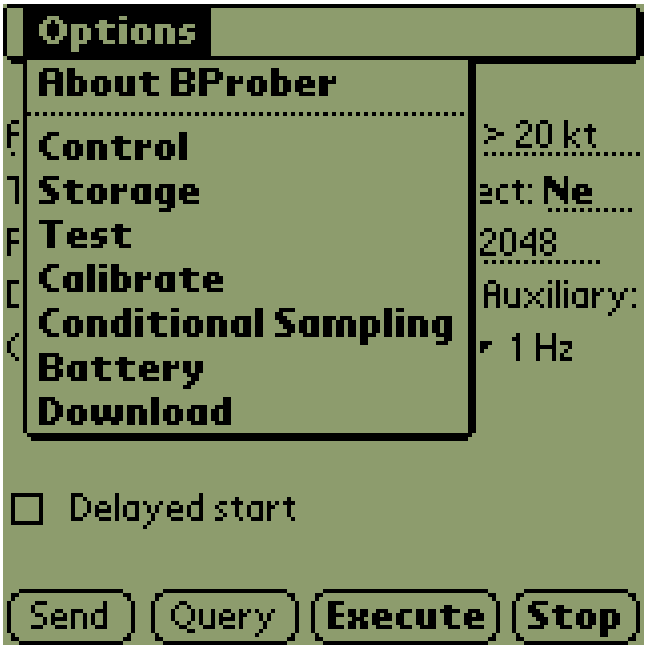

Figure 2. The BProber menu.

5.2 THE CONTROL PAGE

Figure 3 shows an example of BProber's **CONTROL** page. This is the page used to provide the B-Probe with a sampling program, and to start and stop sampling. The following explains how to use the fields on the **CONTROL** page.

5.2.1 Title

The **Title** field, at the top of the page, provides a place to record aspects of the experiment. This text will be embedded permanently in the data-file headers. In the example, the user has noted that an alternate attachment method was used, and recorded wind speed during the experiment. Other things to consider writing into this field are the name of the experiment or cruise, the order of this effort ("third attempt with magnesium release"), or a location ("SB Channel"). *There is no need to enter the date, time, unit serial number, or sampling rate, because these are kept automatically.*

5.2.2 Station/Subject

The two-character station/subject code is used to distinguish data files, so use something that can help you determine which file you want to open once the data have been transferred to your analysis computer. In the example, "Ne" refers to Newport, the location of the test. You could also use, for example, "SB" for Santa Barbara, "S3" for subject number three, "T3" for test number three, "5k" for 5-km range, etc.

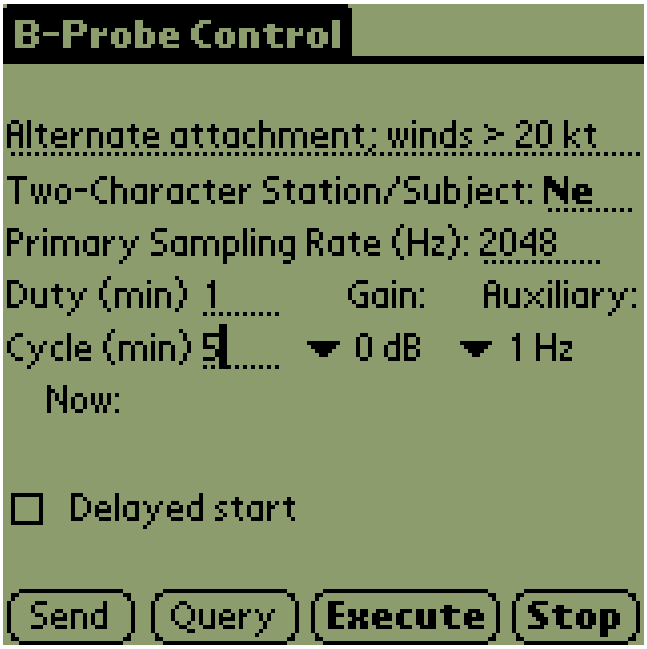

Figure 3. The BProber Control page.

5.2.3 Primary sampling rate

This is the rate at which acoustics will be sampled. The B-Probe supports a broad selection of sampling rates, up to 20312 Hz. You use this field to enter your desired sampling rate; when you press **Send** the B-Probe will determine the closest sampling rate it is capable of, and return this value in the confirmation packet it sends back to your PDA.

Note that sampling rates over 10159 Hz draw heavily on the battery, and may result in premature battery failure, especially in cold waters. To save power for faster sampling rates you may wish to turn off sampling of auxiliary channels (see the **Auxiliary** section below).

5.2.4 Gain

B-Probes come with one of two hydrophone sensitivities; one saturates at about 172 dB re 1 μPa (0–pk), the other at about 190 dB. **Gain** will amplify signals before sampling, but will also lower the saturation limit. You can check the acoustic saturation limit resulting from the current gain setting using the **CALIBRATE** page.

5.2.5 Auxiliary

The default sampling rate for the auxiliary channels (pressure, temperature, optional 2-D accelerometer) is 1 Hz. You may choose instead to sample at 4 Hz, or to turn auxiliary sampling off altogether. The latter may be useful to increase the Probe's sampling lifetime in cases when you expect the acoustic sampling program to draw heavily on the battery; auxiliary sampling places a momentary strain on the battery that may trigger an early power failure as the battery nears depletion.

5.2.6 Acoustic Duty/Cycle

Acoustics may be sampled synoptically, with the sampling program expressed as **Duty** minutes out of every **Cycle** minutes. Sampling windows will be aligned with the real-time clock; for example, a duty/cycle of 2/5 will record acoustics from 11:00 to 11:02, 11:05 to 11:07, 11:10 to 11:12, and so on.

Cycle should be a value that divides evenly into a day (1440 min).

The default duty/cycle is 1/1, which requests continuous acoustic sampling. A duty/cycle of 0/1 may also be selected, in which case no acoustic data will be collected.

Regardless of the acoustic duty/cycle chosen, auxiliary data channels such as pressure and temperature will be sampled continuously until the program is stopped or the storage unit fills (unless auxiliary sampling has been explicitly disabled using the **Auxiliary** drop-down menu).

5.2.7 Delayed start

If you want the B-Probe to begin sampling at some specified time in the future, select **Delayed start**. This will cause a button labeled **Wake** to appear, which will allow you to select your desired wakeup time. Neither acoustics nor auxiliary data will be sampled until the B-Probe wakes up.

Enabling **Delayed start** and selecting a start date and time programs the B-Probe, but does not "arm" it. To tell the B-Probe that you are through adjusting its programming and wish it to execute the sampling program, with or without a delayed start, you must press **Execute**. Otherwise the B-Probe will remain in **STANDBY** and will not perform the desired sampling program.

5.2.8 Send

The **Send** button sends your sampling program to the B-Probe. You should continue to keep the PDA and B-Probe positioned for infrared communication, because the B-Probe will respond to a **Send** command by returning the sampling program it was able to accept.

5.2.9 Query

Query requests that the B-Probe transmit its current sampling program. Use **Query** to verify that the B-Probe has been set up properly.

5.2.10 Execute

When you are satisfied that the B-Probe has been set up with the desired sampling program, press **Execute** to engage the program. If you have not requested **Delayed start**, the B-Probe will flash the alert LED and sampling will begin immediately.

If you have requested **Delayed start**, the B-Probe will flash upon receiving the **Execute** command, but will enter **DOZE** instead of **SAMPLING** mode. To increase confidence that the B-Probe is operating properly, the alert LED will flash at the top of each minute for five minutes after the **Execute** command is given. After that the B-Probe will cease all visible activity until the requested wakeup time.

5.2.11 Stop

Use **Stop** to request that the B-Probe cease any sleep or sampling that may be in progress. In fact, any attempt at infrared communication – not just the **Stop** command – will cause the B-Probe to abort **SAMPLING**; however, the **Stop** command provides a convenient way to end sampling without accidentally causing the B-Probe to do anything else. Sending **Stop** when the B-Probe is in **STANDBY** will have no effect, except that the B-Probe will respond with an infrared alert to your PDA, informing you that there was nothing to stop.

5.3 CONDITIONAL ACOUSTIC SAMPLING

As of Firmware 1.5 you may request that the B-Probe sample its acoustic channel only under specified temperature conditions. Similar to the **Duty/Cycle** control on the **CONTROL** page, conditional sampling only affects whether or not acoustic data are acquired. Auxiliary data will be acquired regardless of the conditional-sampling settings, and in fact must be acquired in order to evaluate the requested conditions.

The B-Probe respects the **CONTROL** page's **Duty/Cycle** settings in addition to any conditional-sampling settings. Thus, even if the requested conditions are satisfied, the B-Probe will not sample acoustics if it is in the "off" portion of the assigned duty cycle.

If **Delayed start** has been selected (see the earlier description under the **CONTROL** page), no sampling or conditional evaluation of any kind will take place until the specified start time.

5.3.1 Enabling and selecting execution type

Figure 4 shows BProber's controls on its **CONDITIONAL SAMPLING** page. To enable conditional sampling, you must check the **Conditional acoustic sampling** checkbox. You must also select whether you want the requested conditions to determine when acoustic sampling can first begin – after which it will continue according to the **Duty/Cycle** parameters without regard for the conditions – or to determine whether or not acoustic sampling is enabled throughout the sampling program.

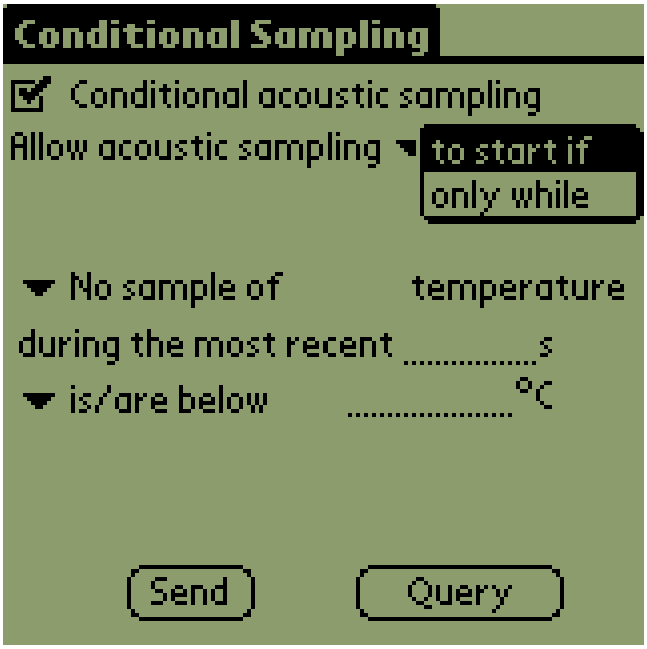

Figure 4. BProber's Conditional Sampling page.

5.3.2 Selecting evaluation type and period

Figure 5 shows available choices for evaluation type. Evaluation takes place over the most recent samples of temperature. You must specify the length of this evaluation period in seconds. The minimum period is either 1 second or 1/4 second (depending on whether auxiliary channels are being sampled at 1 Hz or 4 Hz, respectively). The maximum period is just over two hours (7200 seconds).

5.3.3 Selecting comparison type and criterion

Comparison type is either **above** or **below** the specified criterion. The criterion is assumed to be in degrees C.

5.3.4 Send and query

After choosing your conditional-sampling parameters, you must send your settings to the B-Probe. The B-Probe will respond with the parameters it has accepted. Use the **Query** button to ask the B-Probe for its current conditional settings without sending any parameters.

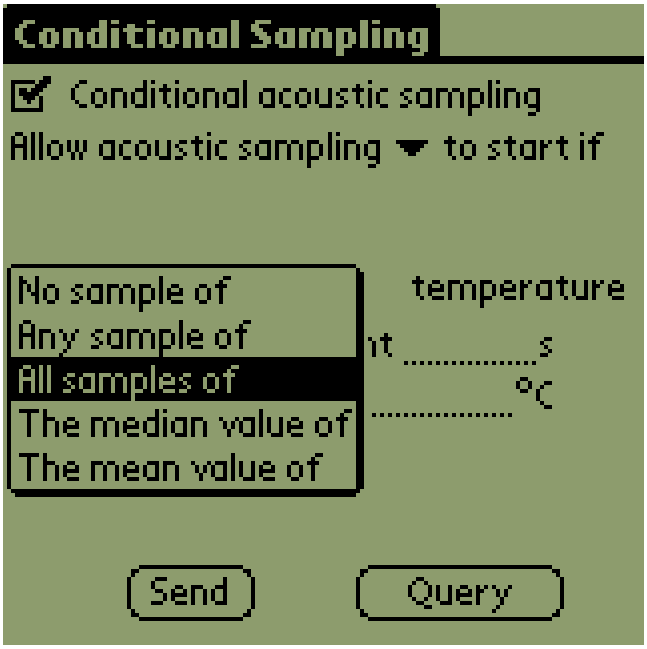

Figure 5. Conditional evaluation types.

5.4 VIEWING CALIBRATED MEASUREMENTS

The **CALIBRATE** page allows inspection of current measurements from the Bioacoustic Probe's auxiliary sampling system. You may request the measurements calibrated in real-world units according to the instrument's calibration data, or you may request the raw quantized samples before calibration. You may also ask for the limits of the auxiliary sensors; the values provided by the Bioacoustic Probe will reflect either the recommended hardware limit or the A/D saturation level for each channel.

Caution: Firmware 1.5.2 and BProber 1.7.2 allow the user to check the saturation limit of the acoustic data channel in dB re 1 μPa (0-pk). Note, however, that any acoustic gain currently set via the* CONTROL *page will factor into the saturation value reported. To obtain the maximum saturation value, be sure that gain is set to 0 dB using the* CONTROL *page.

5.4.1 Zeroing the pressure offset

The **CALIBRATE** page offers the ability to re-zero pressure. This changes the Bioacoustic Probe's calibration data to consider the currently measured pressure as "zero pressure." It is best to do this when the Bioacoustic Probe is at or near deployment temperature to minimize the effects of temperature-induced offset drift, especially for units shipped before Firmware 1.5 (see below).

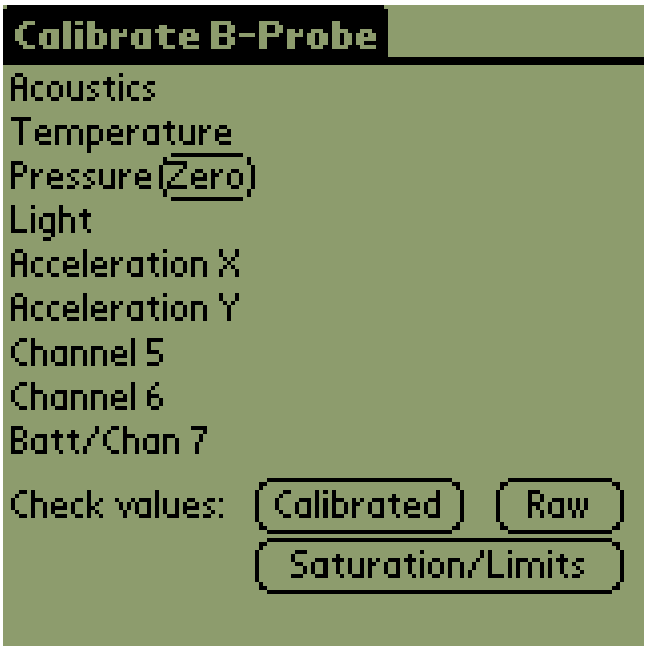

Figure 6. Checking calibrated measurements in BProber. The "Raw" and "Saturation/Limits" buttons allow access to current binary sample values and maximum sensor values, respectively.

5.4.2 Zero-drift temperature compensation

Firmware 1.5 provides the ability to compensate pressure measurements for offset drift due to temperature. Zero-drift compensation is active when the **CALIBRATE** page shows the zero-drift compensation icon (Figure 7) to the right of a pressure measurement obtained from a Bioacoustic Probe. If no icon is visible, no compensation is taking place.

Once active, zero-drift compensation affects all pressure measurements. Unlike other aspects of calibration, zero-drift compensation is applied before acquired data are stored; the digital pressure samples recorded by the Bioacoustic Probe are not identical to the "raw" samples originally acquired by the analog-to-digital converter. Measurements besides pressure are not affected by zero-drift compensation.

Instruments shipped prior to Firmware 1.5 have not been calibrated for zero-drift compensation and therefore do not have it enabled. However the necessary calibration may be performed by the manufacturer, or by the user with manufacturer's guidance, to allow use of this feature under Firmware 1.5.

Figure 7. The zero-drift compensation icon. This icon to the right of the pressure measurement in the **CALIBRATE** page of **BProber** indicates that zero-drift compensation is active.

6 PREPARING YOUR PERSONAL COMPUTER TO COMMUNICATE WITH THE BIOACOUSTIC PROBE

Data may be downloaded to laptop or desktop computers running either Apple Mac OS X or Microsoft Windows 2000 or XP operating systems. Windows 2000 and XP offer built-in support for the industry-standard IrOBEX protocol used by the Bioacoustic Probe; no extra software or driver installation is necessary. For OS X, the `xobex` software bundled with the Bioacoustic Probe provides IrOBEX functionality as well as control over specific download-request parameters.

6.1 HARDWARE PREPARATION (WINDOWS AND OS X)

If your Windows 2000 or XP computer has built-in infrared hardware, no additional hardware or driver installation is necessary. Note, however, that PC-compatible notebook computers equipped with an infrared port generally disable that port by default. You may need explicitly to enable the infrared port (sometimes labeled "IRDA") in the BIOS. BIOS setup commands differ substantially between PC's; consult the manual for your model of PC.

For OS X computers, or for Windows computers lacking built-in infrared support, an infrared dongle is required. Under Windows the dongle need only be compatible with your OS version (2000 or XP); check the manufacturer's literature. Under OS X, the `xobex` software requires a serial dongle in addition to a USB-serial adapter, as discussed in detail in Section 3. Be sure the USB-serial adapter's software driver has been installed on your computer before attempting to use it. Attach the infrared dongle to the serial adapter, and plug the adapter's USB plug into your computer's USB socket.

6.2 SOFTWARE PREPARATION (OS X ONLY)

Open your home folder window in the Mac OS Finder. If you do not already have a `bin` (all lower case) folder under your home folder, create one. Copy all the files from the `bin` folder on your software disk into this `bin` folder. These files are executable programs (analogous to ".EXE" files under Windows) that you will need to work with the Bioacoustic Probe. These "bin"-files include `xobex`, `mtsplit`, and `mtjoin`.

Programs you drag and drop from your software disk to the `bin` directory should automatically be marked by your computer as executable. If you obtain updates by other means, such as through an e-mail attachment or a network file transfer, executable files may not be marked properly. To check if the files are properly marked, you will need to run the OS X application **Terminal**, found in the `Utilities` folder located under your `Applications` folder. Once you have the command line prompt, change directory to your new `bin` directory with the command

```
cd bin
```

then give the "long" directory list command (where the "`l`" character is the letter ell, not the number one)

```
ls -l
```

You should see something like

```
-rwxr-xr-x 1 burgess staff 20580 Nov 7 2002 mtjoin
-rwxr-xr-x 1 burgess staff 16152 Oct 22 2002 mtsplit
-rwxr-xr-x 1 burgess staff 106796 May 6 14:09 xobex
```

where the "x" characters mark these files as executable. If you do not see the "x" characters, give the command

```
chmod +x ~/bin/*
```

and all files in your `bin` folder should now be marked executable.

6.2.1 Using xobex under OS X

The `xobex` program allows you to transfer data files to and from the Bioacoustic Probe. The specific applications of `xobex` are described in later sections.

The `xobex` software is still in development. At the present time, it does not keep track of the available serial ports, nor does it remember which serial port to use from one transfer to the next. Because of this, every time `xobex` is run, you must specify which serial port in the OS X "list" to use.

```
xobex -1
```

uses the first serial port in the "list",

```
xobex -2
```

uses the second, and so forth. Typically your Mac will have only one serial port – the one you added by plugging in the Keyspan serial adaptor – and you will always use `-1` as the first argument to **xobex**. Depending on your hardware configuration and on which version of OS X you are running, however, you may find that you need to specify `-2` or even `-3`.

If you have multiple serial adaptors, you may be able simultaneously to download data from multiple Probes by opening several **Terminal** windows and executing **xobex** with a different serial channel in each one.

Because `xobex -1` is the typical base **xobex** command, the remainder of this manual uses it for examples. Remember to substitute `-2` or `-3` for `-1` if you have found it necessary.

6.2.2 OS X 10.2 "Jaguar"

If your PC is running OS X 10.2 ("Jaguar") but not the later 10.3 ("Panther"), you will need manually to modify your "search path" in the Terminal window to allow you to run the applications you copied to your `bin` folder. To do this, you give the command

```
set path=(~/bin $path)
```

This command will include your `bin` directory in your search path during the current terminal session. To make it permanent so that future terminal sessions will automatically include this command, give the command

```
echo "set path=(~/bin $path)" >> ~/.cshrc
```

These `path` commands are not necessary under Mac OS 10.1.5 or before. OS X 10.3 "Panther" does require these commands, but in a different format; see the next section.

6.2.3 OS X 10.3 "Panther" or later

OS X 10.3 ("Panther") also requires manual modification to the default search path to allow you to run the applications you copied to your `bin` folder. However, the protocol is different from "Jaguar." In a Terminal window under "Panther", you give the command

```
PATH=~/bin:$PATH
```

To make it permanent so that future terminal sessions will automatically include this command, give the command

```
echo "PATH=~/bin:$PATH" >> ~/.profile
```

7 UPLOADING NEW FIRMWARE

New firmware may be uploaded to the Bioacoustic Probe via its infrared interface. Uploading new firmware has only been tested under the Macintosh OS X operating system. The following instructions refer only to OS X.

The Probe's firmware file is named **B002B.S19** – note that the capitalization is important. The Probe will refuse to acknowledge files which do not have this exact name.

Uploading is a simple process. First, make sure that the Probe is powered up on an external power adaptor (NOT a battery), and it is in **STANDBY**, waiting for infrared instructions. Then open the **Terminal** program under Mac OS X, and navigate your directories using the UNIX **cd** command until you are "in" the same directory as the file **B002B.S19**. Then give the command

```
xobex -1 B002B.S19
```

with the infrared dongle pointed at the infrared port of the Probe.

Once the Probe acknowledges the connection and begins uploading the file, it begins to flash its LED rapidly. The process takes approximately 30 seconds. The Probe announces successful completion of the upload by flashing a note alert (a characteristic pair of long flashes with a 1-second period). If you are unsure whether you saw the note alert, check the log on the **Terminal** window to verify that the number of bytes transferred by xobex matches the number of bytes that were supposed to be transferred.

Once you are satisfied that the firmware uploaded properly, you may reset the Probe (by swiping a magnet past the magnetic switch, or by power-cycling) to begin using the new firmware.

Caution: TAKE CARE THAT ONLY ONE ACTIVE PROBE IS IN VIEW OF YOUR COMPUTER'S INFRARED PORT WHILE UPLOADING NEW FIRMWARE. It is possible for another Probe in the line-of-sight of the upload process to corrupt its firmware in response to a perceived firmware upgrade request.

Caution: DO NOT upload new firmware to your Bioacoustic Probe unless specifically advised by the manufacturer. UPLOADING NEW FIRMWARE WITHOUT SPECIFIC MANUFACTURER INSTRUCTIONS TO DO SO WILL VOID YOUR WARRANTY.

Caution: DO NOT interrupt a firmware upload! Doing so will corrupt your firmware and you will be unable to boot the Probe. NEVER UPLOAD NEW FIRMWARE TO A PROBE POWERED BY ANYTHING OTHER THAN THE POWER ADAPTOR.

Caution: If you have reason to believe that the firmware upload process did not complete properly – especially if you did not observe the note alert at the end of the upload flashing sequence, or the personal computer log does not indicate that the entire file was transferred – PERFORM THE UPLOAD PROCEDURE AGAIN IMMEDIATELY! Do NOT reset the Probe until you are confident that the firmware was properly transferred.

8 DATA FILES

8.1 THE BIOACOUSTIC-PROBE FILE SYSTEM

The Bioacoustic Probe maintains four distinct file types, as follows:

Log file — A small text file providing the history of the Probe since its storage unit was last cleared. Startup and error messages are written to the log, as well as information regarding sampling activity.

Calibration file — A small text file listing the Probe's serial number and hardware revision, and the current calibration settings for all of its sensors.

Directory file — A larger text file listing all data files on the mass storage unit. Log and calibration files are not listed in the B-Probe directory file.

Data files — Each data file contains data from a single sensor only, and can be as large as 4 MB. When downloading data, one can also download the log file as a "virtual" data file using its channel number 31.

Channel	Description
0	Acoustic
10	Pressure
11	Temperature
12	Light
13	Battery
14	Accelerometer (X axis)
15	Accelerometer (Y axis)
31	Log

8.1.1 Data files, superfiles, and timestamps

The Bioacoustic-Probe filesystem maintains a separate data *channel* for each sensor. When sampling begins, the B-Probe writes a timestamp on each data channel. This timestamp identifies the beginning of a new data file within each channel.

After the starting timestamp, the B-Probe periodically inserts additional timestamps into each data channel, even when the data on either side of the timestamp were contiguously sampled. As with the starting timestamp, each intermediate timestamp also marks the beginning of new data file within the channel. This practice facilitates detection and recovery in the event that, due to a fault, the B-Probe improperly drops or inserts samples. It also provides a means to address and download subsets of the data channel.

When downloading data from the B-Probe, one often wishes to obtain multiple files from a given data channel with one download command. The B-Probe provides this capability by downloading the files requested as a single data *superfile*. Superfiles contain a sequence of data from a given channel, complete with embedded timestamps. To be accessed individually, the component files must be split from the superfile. This splitting process is described later.

8.1.2 The B-Probe data-file directory

Below are a few lines of a sample directory file:

```
00000 4677 07.12 1130:02 BB Sound
00001 4717 07.12 1134:00 BB Sound
00002 4717 07.12 1138:00 BB Sound
00003 4717 07.12 1142:00 BB Sound
10000 0012 07.12 1130:01 BB Press
11000 0012 07.12 1130:01 BB Temp
```

These entries give the **file number**, the **file size** in kilobytes, the **month.day**, the **start time**, the **station code**, and the **channel description**.

Note that the five-digit **file number** is coded to contain two digits of **channel number** and three digits of **file index**. Thus the final line of the example is for file index 0 of channel 11 – the temperature channel.

8.1.3 B-Probe memory and filesystem

The Bioacoustic Probe may store its log file, and all data files, in either volatile memory or the non-volatile filesystem depending on how and when the files were created. Under rare circumstances, you may wish to ask for a log or data file to be downloaded from volatile memory. In general, however, you will ask for a file to be downloaded from the filesystem. When using **xobex** for downloading you do not have a choice; all downloading done using **xobex** will be from the B-Probe's filesystem, not from volatile memory.

The log file is kept in a 4-KB buffer in volatile memory. As the log grows, the buffer is periodically written to the filesystem. The log is also saved to the filesystem when major events occur, such as the beginning or end of a sampling program, or a shutdown due to low battery voltage. If you wish to see if any log entries have occurred that have not been saved to the filesystem, download the log from volatile memory using your PDA.

Data files acquired during normal sampling are transferred to the filesystem shortly after acquisition. Thus, unless you are explicitly exercising the acquisition test functions, you will always wish to download data files from the filesystem.

Procedures given in the rest of this document are for downloading from the filesystem.

9 DOWNLOADING FILES TO YOUR PDA

Palm-compatible PDAs can be used to view small text files, such as the B-Probe log, directory, or calibration files. **Note that data files, such as acoustic or temperature records, can NOT be downloaded to your PDA.** Typical PDA storage and battery capacity are small and most likely inadequate to transfer large amounts of data. Also, Palm PDA's will refuse to store data if no Palm application is loaded to handle those data, and at present there is no Palm application available to view or inspect the binary data files from the B-Probe.

When you have your PDA ask the B-Probe to download a text file, the file will be sent immediately to your PDA. The Palm OS will present a dialog asking you if you want to store the file. If you accept, the file will be opened in the **Memo Pad** Palm application. Newer Palms may open the files in a Microsoft Word emulator instead.

9.1 DOWNLOADING THE LOG FILE

One will typically examine the log file after the Probe is recovered from a deployment. The log file will indicate whether sampling finished normally, or was abnormally terminated by power failure or some other error.

Because the log file is a small text file, it is simple to download it directly to your Personal Digital Assistant (PDA). Using the `Download` page of the **BProber** PDA software, select `Log` from the drop-down `Select data channel` menu, select `Data/Log` from the drop-down `Download type` menu, and press the `Download` button.

9.2 DOWNLOADING THE CALIBRATION FILE

Select `Calibration` from the `Download type` drop-down menu on **BProber**'s `Download` page. Press the `Download` button.

If you wish to modify the calibration file, you can edit it in the Palm OS **Memo Pad** application and use the `Beam File` menu item to send it back to the B-Probe.

A password is required for the B-Probe to accept a modified calibration file.

9.3 DOWNLOADING THE DIRECTORY

Select `Directory` from the `Download type` drop-down menu on **BProber**'s `Download` page. Press the `Download` button.

Note that when the filesystem has many files, the directory may be larger than the Palm OS **Memo Pad** application can handle. In this case, the Palm OS will automatically break the directory into several memos. The Palm OS does this inelegantly and it may be difficult to determine which memo you want to view.

A better solution, for large directory files that would otherwise overflow the **memo pad**, is to download them to a desktop or laptop computer. This is covered in the following section.

10 DOWNLOADING FILES TO YOUR PERSONAL COMPUTER

Both Windows (2000 or XP) and Macintosh (OS X) computers can receive files transmitted via infrared by the Bioacoustic Probe. Under OS X it is possible to manage all data downloading directly from the personal computer without the use of a PDA. This is not presently possible under Windows.

10.1 DOWNLOADING FILES TO WINDOWS

Be sure your Windows computer has infrared capability and that this capability has been enabled, if necessary, in the BIOS. Using your PDA, command the Bioacoustic Probe to download the desired file by going to the `Download` page of `BProber`, selecting the desired data channel and download type from the drop-down menus, and pressing the `Download` button.

Once the sequence of PDA infrared-status windows complete, indicating that the Bioacoustic Probe received the download command, quickly move the Bioacoustic Probe to where its infrared port has clear line of sight to the corresponding port on the Windows computer. A dialog will appear on the Windows computer asking if you wish to accept download of the file. Quickly confirm the dialog and the download will begin.

10.2 DOWNLOADING FILES TO OS X

Unlike Windows, which is always attempting to initiate infrared connections, OS X must be told to watch for or engage in infrared transfers using the custom `xobex` software supplied with the Bioacoustic Probe. The `xobex` software must be installed before it can be run. Section 6 describes installation and basic use of `xobex`.

10.2.1 Downloading files to OS X under command of your PDA

To tell OS X to receive a file via infrared, use the command

```
xobex -1
```

and OS X will wait about 30 seconds for an infrared connection. With OS X now listening, you may use the PDA to request a download as described above for Windows 2000 and XP computers.

You can test this function without using the Bioacoustic Probe. Open the `Memo Pad` application on your PDA and select or create a short text memo. The `Beam Memo` menu item of the `Memo Pad` application will send the memo to your computer via infrared, provided the computer is listening properly.

10.2.2 Downloading files to OS X under command of xobex

For data, log, and directory files, a PDA is not necessary to initiate an infrared transfer to a listening `xobex` client. The transfer can be initiated directly from the computer using forms of the `xobex` command.

Downloading all files from a specified channel

For data files, the command

```
xobex -1 -cX
```

will send a request to the B-Probe to download all data files acquired from channel X. For example

```
xobex -1 -c10
```

will ask the B-Probe to download all pressure files. The log and directory files may be downloaded using the `-l` (letter ell) and `-d` options respectively. For example,

```
xobex -1 -d
```

will request download of the file directory.

Downloading selected files from a specified channel

Often you will want to download only a fraction of the files stored in the filesystem. To download all files of a channel X with file index Y and after, type

```
xobex -1 -cX -fY
```

To download all files of a channel X between indices Y and Z inclusive, type

```
xobex -1 -cX -fY -eZ
```

11 WORKING WITH DOWNLOADED FILES

11.1 SPLITTING AND JOINING DOWNLOADED FILES

The B-Probe periodically inserts timestamps into all data it acquires. This practice facilitates detection and recovery in the event that, due to a fault, the B-Probe improperly drops or inserts samples. However, it also means that, if you have downloaded two or more data files with a single download request, you must split this superfile to remove the embedded timestamps. Once downloaded files have been split, you may choose to recombine them to form a single data file covering a longer period of time.

11.1.1 Windows

At press time, Greeneridge Sciences/Acoustimetrics did not maintain splitting or joining software for use under Windows. However, the Applied Physics Laboratory of the University of Washington has adapted Acoustimetrics' software for Windows in a program called `Bio Prob.exe`. This program is included on the distribution CD-ROM as a courtesy to Windows users. Note that Acoustimetrics cannot offer support for this software at the present time.

11.1.2 OS X

Splitting superfiles is accomplished using the command-line program **mtsplit**. Open a **Terminal** window, use the `cd` command to select your working directory to be that in which the superfiles reside, and enter the command

```
mtsplit xxxx.mt
```

where `xxxx.mt` is the name of the superfile, for example, `bp10.mt`. **mtsplit** will automatically choose filenames reflecting the contents of the split data files.

Once you have split files, you may wish to recombine them. The process of recombination evaluates the files to be sure that they are compatible for joining. In particular it checks for dropped or improperly inserted samples.

To combine two or more data files using a single command line, give the command

```
mtjoin tofile.mt
```

This will append onto `tofile.mt` all files in your current working directory that follow `tofile.mt` in time. This command alters `tofile.mt`, but not any other file. Files preceding `tofile.mt` will not be appended. Appending will stop when the year (embedded in the filename) turns over, when there are no more files to append, or when a time gap in the files is found.

If you wish to delete all the files appended to `tofile.mt` as they are appended, give the command

```
mtjoin -d tofile.mt
```

Sampling according to a duty cycle will sometimes result in data files that are grouped by time. For example, recording 15 minutes out of every hour will result in a series of sequential data files (corresponding to the 15 minutes of "on" time) followed by a gap of 45 minutes, then another 15 minutes of data files, and so on. If called with the with the -c ("cluster") option, **mtjoin** will join such clusters of data files together into single data files representing each "on" period. Without the -c option, **mtjoin** will stop when it encounters the first time gap between files. If using the -c and -d options together, just use a single dash-option field, like so:

```
mtjoin -cd tofile.mt
```

If you wish to join together two specific files without using the automatic file-search behavior built into `mtjoin`, use the command

```
mtjoin tofile.mt fromfile.mt
```

As before, this command will alter `tofile.mt` but not `fromfile.mt`. No other files will be joined together.

11.2 ANALYZING DOWNLOADED FILES IN THE TIME DOMAIN

The MATLAB M-file **MTRead.m** allows MT files to be read into MATLAB under any operating system supported by MATLAB, including Windows and OS X.

Under OS X, the unsupported software **MT Viewer** can be used to view the data files from the B-Probe in the time domain. It allows scrolling, zooming, playback, and several other features.

Documentation for **MT Viewer** is beyond the scope of this manual, however the program is simple to use. Pay close attention to the command-key equivalents listed in the menus, as they can save you a lot of time over using the mouse.

Unlisted key equivalents include the space bar (page forward) and shift-space (page backward).

11.3 ANALYZING DOWNLOADED FILES IN THE FREQUENCY DOMAIN

As mentioned above, the M-file **MTRead.m** can read MT data into MATLAB for both time- and frequency-domain processing on most platforms.

12 TROUBLESHOOTING

The Bioacoustic Probe fails prematurely. Sometimes the log indicates that the power failed, sometimes the instrument simply resets itself, but the batteries are fresh.

Did you clean the contacts in the battery compartment and on the battery itself? The importance of clean contacts cannot be overemphasized. In laboratory tests this step alone increased supply voltages at the electronics by 50–100 mV at a 10-kHz sample rate, corresponding to hours of additional battery life.

If you have a A-series instrument, or B-series serial number 025 or before, **have you cleaned the positive battery spring and screwhead?** The stainless steel screwhead rapidly builds up tarnish, especially in a marine environment, and must be thoroughly cleaned before deployment. See Section 2.2.

Are you using the right batteries? The Saft LS 14250 battery has been found to perform best in this application. Don't use the LST 14250 or the LS 14250C as they have poorer current specifications.

Did you conduct power-hungry operations with the battery before deployment? Data transfers and erasing of storage draw very heavily on the battery. Use shore power for these operations.

How fresh are your batteries? Have they been in storage for several months or longer? Have they been stored in heat or humidity? Were they used even slightly before storage? All these factors can lead to increased internal resistance in the battery. If you have a B-series instrument, try deliberately placing the battery in backwards. A bright yellow light will come on to alert you that the battery is improperly placed. Leave the battery in backwards for 3–5 minutes, and then try again. **DO NOT DO THIS WITH AN A-SERIES PROBE.**

Have you tested any batteries from this batch? Whole batches of batteries sometimes fail to meet specifications. You may have a bad batch.

How cold is it? Batteries peform poorly in cold temperatures. Try turning off auxiliary sampling or reducing the acoustic sample rate.

How wet is it? If batteries were inserted in a humid space and the B-Probe was subsequently put in cold water, condensation may be robbing some of your battery voltage. Try inserting the battery in a place with dry air, or purging the battery compartment with a quick blast from a nitrogen purge can as you seal it. Alternately, if a tiny dessicant bag can fit under the battery-cap spring this may be effective.

How fast are you sampling acoustics? The Bioacoustic Probe was originally designed for sampling rates around 1–4 kHz. Sampling above 10159 Hz draws heavily on the battery. Try turning off auxiliary sampling or reducing the acoustic sample rate.

The B-Probe seems to take almost two minutes to boot, and flashes the system LED every second or so the whole time it's booting.

The B-Probe's storage unit has a significant amount of data. You are seeing the LED flash in association with the filesystem rebuild that takes place each time the B-Probe starts up. See the section on the **REBUILD** mode.

I obtained new executable software files (xobex, mtsplit, and mtjoin) for running in the Mac OS X Terminal window, and placed them in the bin folder of my home directory, but when I try to run them I get the error message "Permission denied."

The software files are not properly marked as executable. To mark all the files in your `bin` folder as executable from your **Terminal** window, type the command

```
chmod +x ~/bin/*
```

My data files all have the wrong time.

Your PalmOS PDA was not set to the correct time when you were commanding the Probe with it. You must be certain to set your PDA to the correct time before using it to interact with the Probe.

The B-Probe didn't start sampling when I removed the magnet I had taped over the magnetic switch.

The B-Probe will not sample when a magnet that had been held against its switch is removed. The magnetic switch resets and shuts down the entire instrument, including the clock; when the magnet is removed the B-Probe boots up from scratch and must be commanded via infrared in order to obtain the correct time and begin sampling.

I can't get data files from the B-Probe to my Windows PC. The infrared link is either broken or unreliable.

Data-transfer problems usually result from (a) excessive distance between the B-Probe and the PC's infrared port; (b) confusion in the handoff from commanding the download with the Palm to presenting the B-Probe to the PC's infrared port; and (c) excessive delay in the user's acceptance of the Windows infrared-file-acceptance dialog. To ensure smooth transfer of data:

- Be sure that the B-Probe is within range of the adapter. Some infrared adapters have very limited range. An adapter tested in-house required the B-Probe to be positioned 10–15 cm from the adapter.
- Be sure that the Windows infrared port does NOT "see" the B-Probe when you are commanding the B-Probe with the Palm. This can be accomplished by temporarily blocking the port with your hand or fingers, or by commanding the B-Probe out of range or sight of the port and then immediately afterwards placing the B-Probe in position near the port.

- Have the PC ready for the transfer. Clear the screen of other work, so that you will see the infrared-accept dialog clearly when it appears. Be ready to OK the transfer with a mouse-click or by pressing the return key.
- Move quickly once the download command has finished transmitting from the Palm to the B-Probe. The timeouts are set for just a few seconds. If the B-Probe doesn't find the PC in a few seconds, or if you don't OK the PC's infrared-accept dialog within a few seconds of its appearing, the transfer will abort.
- Check for interference from other possible infrared sources. Other notebook computers with infrared ports nearby, other B-Probes, or even flourescent lighting or bright sunlight can interfere with infrared transmission.

If your infrared port doesn't seem to work at all, make sure you have it turned on in the BIOS; this applies only to built-in infrared ports, such as those on notebook computers. Also, if you are using Windows 2000 or before, you may need to load drivers for your USB/infrared adapter (Windows XP has the necessary drivers built in).

After over a day of offloading someone bumped my Windows computer and the infrared link was broken before the transfer finished. I can't find the partial data file on the Windows desktop, where is it located on the Windows filesystem? Don't tell me I have to start from scratch.

You have to start from scratch. It appears that Windows discards the proceeds of interrupted data transfers. If you have any reason to suspect your transfer may be interrupted, consider requesting partial data transfers by specifying a file range when commanding the download with **BProber**. This is only a potential issue when using Windows; under OS X the supplied **xobex** application does not delete partial downloads.

I try to download files to my PC, but all that comes over infrared is a file called "dialog.bpr". My PC can't do anything with it.

The "dialog.bpr" file is an information packet that the Bioacoustic Probe intended for delivery to the PDA. Attempt your operation again except with the Palm as the recipient rather than the PC, and you will find out what the B-Probe is trying to tell you. Most likely you are attempting to download a file that does not exist on the storage unit, either because it was never recorded or, especially in the case of the log, the information in volatile memory has not yet been written out to recently-erased storage. In the latter case, you may ask the **DOWNLOAD** page of **BProber** to download "Data/Log, unsaved" rather than "Data/Log".

My Palm-compatible PDA refuses to accept download of data files.

You cannot download data to the Palm PDA, only small text files such as the log. Data files must be downloaded directly to your PC via an infrared connection.

I downloaded acoustic data files from the B-Probe to my PC, but my audio software won't open them.

The B-Probe provides data in MT format, a non-standard format that cannot be read by typical data-analysis applications. To view these files you have three choices: (a) on Mac OS X, you can use the free but unsupported application **MT Viewer** and from there export to WAV, MATLAB, or ASCII formats; (b) under MATLAB, you can import the data using the provided **MTRead.m** m-file; or (c) you can manually excise the first 512 bytes of the file using software such as the open-source program **SoX**, since all remaining data in the file are pure 16-bit data samples. As the first 512 bytes contain metadata such as sample rate, calibration values and start time, however, you may wish to make the latter approach a last resort.

Those performing manual operations on B-Probe data should note that the B-Probe provides acoustic data in "big-endian" format; analysis with a "little-endian" computer – that is, all Intel and AMD-based computers – will require the data to be "byte swapped." Byte swapping is automatically performed as necessary by **MT Viewer** and **MTRead.m**.

The C-language ".h" include file describing the format of the MT header is available should you wish to write or adapt software to read MT format.

I asked to download several files, but I only got one.

The infrared-download operation uses "superfiles" that consist of one or more data files concatenated and transferred as a single file. You will need to split superfiles; see the section of this manual entitled "Working with downloaded files."

The data are marred by bursts of artifact noise at period intervals. There's no way this noise is real, it looks like random bits inserted in the data stream.

If you view a "superfile" that has not been split (see the section of this manual entitled "Working with downloaded files") there will be 512-byte timestamps embedded in the datastream. You need to split the data file, and, if you wish, rejoin it, to remove these timestamps.