Model: SM2+

SongMeter

Wildlife Acoustics, Inc.
Concord, Massachusetts
www.wildlifeacoustics.com
Made in U.S.A. • Patents Pending

MIC L
MIC R
PWR
(6VDC IN)

FC CE

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ACOUSTICS

Song Meter User Manual

Model SM2+

Wildlife Acoustics, Inc.

www.wildlifeacoustics.com

Firmware Version 3.1.0

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Prohibition against Eavesdropping

United States law (Federal Communications Commission Part 15 Section 15.9) states "Except for the operations of law enforcement officers conducted under lawful authority, no person shall use, either directly or indirectly, a device operated pursuant to the provisions of this Part for the purpose of overhearing or recording the private conversations of others unless such use is authorized by all of the parties engaging in the conversation."

You are responsible for complying with all applicable laws within your jurisdiction.

Electromagnetic Interference

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Changes or modifications not expressly approved by Wildlife Acoustics, Inc., could void the user's authority to operate the equipment.

SM2+ Introduction

The Song Meter^{TM} SM2+ is a second-generation acoustic monitoring and data logging platform both flexible to meet a broad range of applications today and expandible to meet future requirements tomorrow. SM2+ was designed from the ground up to be the most cost-effective and reliable solution for the long-term acoustic monitoring of birds, frogs, bats, fish, cetaceans, and other wildlife in harsh field conditions.

You can program Song Meter to record automatically on a schedule. Song Meter has the battery life and memory capacity to record for hundreds of hours spread out through months at a time.

Song Meter recordings can be analyzed automatically by Song Scope^{TM} software, sold separately, to quickly locate species of interest. For more information, please visit our web-site at www.wildlifeacoustics.com.

Updates and Support

Song Meter is field upgradeable, and we frequently add new versions of the firmware to make improvements and add features. Please take a moment to join our mailing list and/or our on-line forum so that you will be notified when new firmware updates are available. The on-line forum is also a place to get support and leave feedback. Please visit www.wildlifeacoustics.com and click on the "Contact" link if you wish to be added to our mailing list, and click on the "User Forum" link to join the discussion board.

Overview

A diagram of the SM2+ weather-proof enclosure is shown in Figure 1 below. This enclosure, when properly closed, is weather tight and vented to protect against condensation and stress on seals caused by pressure changes. While the enclosure is designed to survive temporary immersion in water, it is not designed or recommended for underwater use.

Connectors

The SM2+ enclosure has one cable gland and three connectors as follows. Each connector is designed to make a weatherproof seal when mated or

used with the watertight connector caps (not shown). Unused connectors should always be capped.

Left Mic Input

Right Mic Input

Pressure Equalizaion Vent

External Power Input

Cable Gland
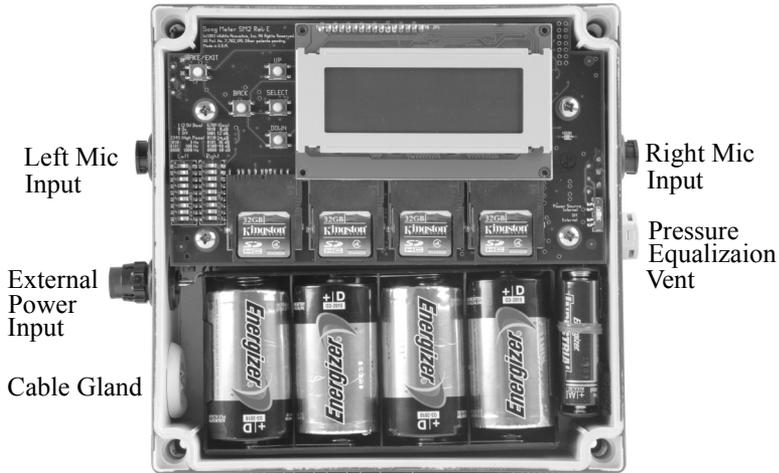
Figure 1—Song Meter SM2+ Connectors

Left and Right Microphone Inputs

The two microphone inputs are for the left and right channels and can mate directly with the SMX-II weatherproof acoustic microphones, or extended on an optional cable. Connection with unauthorized devices may cause damage to the SM2+ and will void the warranty. Please contact us for advice on connecting alternative microphones.

Cable Gland

The cable gland is for the external temperature sensor option or the GPS option and for future expansibility. The SM2+ includes an integrated data-logger for logging internal temperature and with the optional external temperature sensor, can also log external air, water or soil temperature. The Song Meter SM2+ GPS option provides a mechanism to schedule and synchronize recordings to within one

millisecond. An array of time-synchronized recorders can then be used to triangulate the location of a sound source by measuring the relative time-of-arrival of the sound wave as it travels across multiple microphones.

External Power Input

The SM2+ can be configured power selection switch to use either internal power from four D-size Alkaline or NiMH batteries, or external power through this connector. The power connector can safely accept voltages from 4-10V DC and is intended for 6V external battery systems. An optional power adapter is available that provides 5V output to this connector from higher voltage (6-20V) input sources suitable for a 12V solar power system and provides protection against accidental reverse currents and overvoltage. Connection with unauthorized devices may cause damage to the SM2+ and will void the warranty.

Inside the Enclosure

All of the Song Meter electronics, batteries, data storage flash cards, display, and controls are mounted inside the weatherproof enclosure to protect them from the elements, and are therefore inaccessible without removing the enclosure's cover as described in "Removing and Replacing the Cover" on page 9. Figure 2 below illustrates the inside of the SM2+ with various parts described in more detail below.
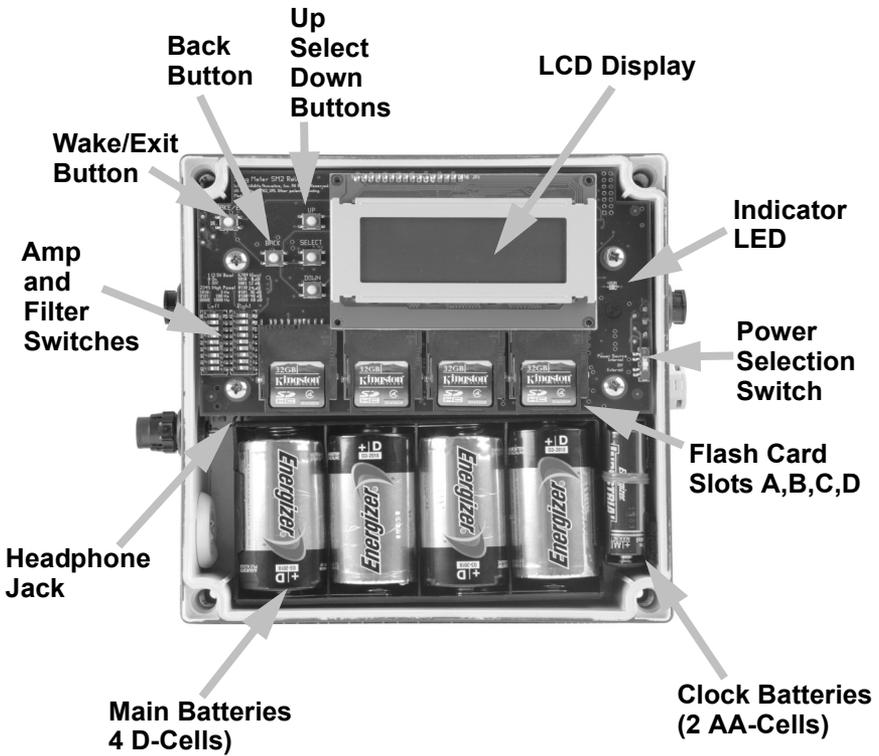
Figure 2—Song Meter SM2+ (Cover Removed)

Main Batteries and Power Selection Switch

The power selection switch can be used to select between "internal" and "external" power sources and to turn the SM2+ "off". If internal power is selected, the four D-size main batteries are used to power the Song Meter. If external power is selected, then power comes from the external 4-10VDC power connector described previously "External Power Input" on page 3.

The main batteries can be NiMH rechargeable or Alkaline batteries. Alkaline batteries are best for long-term deployments because NiMH batteries self-discharge at a rate of about 30% capacity per month.

The SM2+ will drain batteries down to approximately 3.5-3.8 volts. While this is good for long deployments with disposable Alkaline batteries, it can cause damage to NiMH batteries (they may no longer charge properly) because they are not designed to be discharged below about one volt per cell (or 4.0 volts total). So, if you are using NiMH batteries, we recommend that you plan on replacing the batteries before they are depleted.

The SM2+ uses almost no current (around 0.5mA) when "sleeping" between scheduled recording events so it can remain idle (not recording) for months at a time (noting that batteries will discharge on their own over time). When recording, depending on accessories, sample rates, compression, and other variables, the SM2+ can use as little as 50mA current. That translates to almost 280 hours of recording time using high quality Alkaline batteries. See "Managing Power and Memory Resources" on page 30 for more information.

Clock Batteries

The SM2+ uses two AA alkaline batteries to power the clock. These batteries have an expected life of between two and three years. However, we recommend that they are tested and/or replaced at the beginning of each field season because the Song Meter will not operate if they are depleted.

Flash Card Slots A, B, C and D

The SM2+ supports standard off-the-shelf SD and SDHC flash memory cards for storing recordings and data logs. At this time SDXC cards must be reformatted to FAT32 format to work properly. Information on how to do this is available on our Users Forum at www.wildlifeacoustics.com. Support of native SDXC format is planned for a future firmware release.

Recordings are stored in standard ".WAV" format files or in our proprietary ".WAC" lossless compression format. Data is logged in tab-delimited ".TXT" text files. The four card slots can be populated with one to four flash cards of assorted capacities. As of this writing,

today's SDHC cards are available in up to 32GB and SDXC cards are available up to 128GB. With four slots, the SM2+ has a capacity of 128GB using SDHC cards and 512GB using SDXC cards.

Indicator LED

A low-power LED on the board, and visible through a window on the enclosure cover, provides a visual cue as to the status and health of the Song Meter. When sleeping but scheduled to wake up for a future recording, the LED will blink green once a minute for one second. When actively recording, the LED will blink green for a fraction of a second each second. Otherwise, the LED remains off.

The LED is intended to provide some status, but not at the cost of high power consumption. Therefore, it may not be easily seen in bright sunlight or from off angle.

Headphone Jack

The standard 3.5mm stereo headphone jack provides an audio output capability. When making a recording, you can press the "Select" button to toggle the headphones on and off to listen to the recording in progress and check audio levels and quality.

Amplifier Configuration Switches

Several switches are provided to configure the left and right microphone input channels.The switches are arranged in two columns of nine switches. The column on the left controls the left channel and the column on the right controls the right channel.

The first row, labelled "2.5V Bias", enables a 2.5V bias through a 2.2K resistor to the signal input. This is required for most electret microphones including the SMX-II microphones. To enable the bias, the corresponding channel's switch should be switch "on" to the right as follows:

Switch Row	Bias	No Bias
1	On	Off

Rows three through five configure a two-pole butterworth high-pass filter to attenuate unwanted low-frequency sounds. Three frequency settings are available; 2Hz, 180Hz and 1000Hz. Sounds below the configured frequency will be attenuated in the recording. Settings are as follows:

Switch Row	3 Hz	180 Hz	1000 Hz
2	On	Off	Off
3	Off	On	Off
4	On	Off	Off
5	Off	On	Off

The sixth through ninth row configures the gain of the microphone pre-amplifier. The amplification is set as follows:

Switch Row	0 dB	12 dB	24 dB	36 dB	48 dB	60 dB
6	On	On	Off	Off	Off	Off
7	Off	Off	On	On	On	Off
8	On	Off	On	Off	Off	Off
9	Off	On	Off	On	Off	Off

Note that there is an additional third-stage gain for audio rates <=96kHz that can be configured from the user interface for +0 to +12dB additional amplification in 1.5dB increments. Song Meter can therefore be configured for gains between +0 and +70dB in 1.5dB increments on each channel.

LCD Display

A 4-row by 20-column LCD display is used for status and configuration.

Wake/Exit Button

Song Meter normally sleeps until the next scheduled recording time arrives. In order to check or configure Song Meter, it must be woken up manually. Press the Wake/Exit Button to wake up the Song Meter.

To put Song Meter back to sleep and resume the recording schedule, press the Wake/Exit button again. If the Wake/Exit button is pressed during a scheduled recording, the Song Meter will begin recording immediately until the scheduled ending time of the recording, and then go to sleep to wait for the next scheduled recording.

If Song Meter is awake and not recording, it will automatically resume the recording schedule after 5 minutes of inactivity.

Up, Down, Select and Back Buttons

Use the Up, Down, Select and Back buttons to navigate Song Meter's menus. The Up and Down buttons are used to advance to the previous or next menu item or parameter value. The Select button is used to select the menu item or lock in the parameter value, and the Back button is used to back up.

Temperature Sensor

The built-in temperature sensor is located on the motherboard inside the enclosure and can be used to log temperature.

Note that the temperature measured is the air temperature inside the enclosure. If the SM2+ is shaded from direct sunlight, this will generally be reasonably close to the ambient air temperature outside the enclosure. However, if exposed to sunlight, the air temperature inside the enclosure can rise significantly.

See "Sensor Settings" on page 25 and "Data Log Files" on page 45 for details.

Getting Started

Removing and Replacing the Cover

The SM2+ cover has four plastic cover screws in the corners. These screws have clips to prevent them from falling out and getting lost. For best results, use a properly sized flat-head or phillips-head screw driver to turn the screws. Note that the plastic is soft, and use of incorrect tools can damage the heads. When in doubt, a flat-head screw driver is safest. If necessary, you can purchase replacement cover screws from us.

If the enclosure is wet on the outside, we recommend drying it off with a towel before removing the cover. You can then loosen the cover screws by turning them counter-clockwise and lifting the cover straight away from the enclosure body.

To close the cover again, make sure the indicator LED window is correctly oriented over the LED on the circuit board and tighten the screws by turning them clockwise. The foam insert on the inner side of the lid is to prevent battery movement. **Be careful not to over-tighten the cover fasteners.** If the fasteners are too tight, the knife-edge of the cover can warp slightly reducing the effectiveness of the gasket seal. Additionally, there is some risk of stripping the threads. Instead, gently tighten the fasteners until the plastic on the cover just meets the plastic on the enclosure at the corners. Continue to tighten a generous 1/8th turn more. This is equivalent to approximately 9.0 inch-pounds or 1.0 newton-meters of torque.

Installing Batteries

Main Batteries

If using internal batteries, make sure the power source switch is set properly as described in "Main Batteries and Power Selection Switch" on page 4.

Song Meter takes 4 standard "D" size batteries and works with disposable Alkaline batteries as well as rechargeable NiMH batteries.

If you are using NiMH rechargeable batteries, you should make sure they are fully charged as these batteries tend to discharge over time when not in use. **Warning: NiMH batteries can be damaged if discharged beyond**

their capacity. See the section on "Managing Power and Memory Resources" on page 30" for more information.

Be sure to install the batteries in the correct orientation as indicated by the battery holder.

Battery life can vary widely depending on the battery capacity, brand, charger used, temperature, etc.

External Power

Instead of the internal batteries, you can also provide power to the Song Meter from an external 6 or 12 volt battery or solar power system using the optional SM2+ power adapter. Make sure the power selection switch is set to select power from the external connector. The power adapter provides 5V power to the Song Meter through the connector, and provides battery clips to attach to a large 6 or 12 volt battery. The adapter provides voltage protection up to 20 volts and reverse current protection to prevent damage from accidentally reversing the battery polarity.

Clock Battery

Song Meter uses two AA alkaline batteries to power the clock. These batteries should last between two and three years, but we recommend that you check and/or replace them before each field season because the Song Meter will not operate when these batteries are depleted.

Installing Flash Cards

You must install at least one flash card in order for Song Meter to make and store recordings. You may install up to four flash cards for additional storage capacity.

Song Meter supports SD, SDHC and SDXC cards. We recommend using Class 4 and higher cards. At this time SDXC cards must be reformatted to FAT32 format to work properly. Information on how to do this is available on our Users Forum at www.wildlifeacoustics.com. Support of native SDXC format is planned for a future firmware release.

Installing Microphones

The SMX-II weather-proof microphones can attach directly to the left and right microphone input connectors on the Song Meter. Alternatively, they can be

extended on cables. The connector is keyed and the microphone (or cable) can be pushed into the connector when oriented correctly and then locked into place by turning the locking ring on the microphone or cable clockwise.

Note that the microphones are fragile - they should be removed from the Song Meter during transport.

Mounting the Song Meter

You must first remove the enclosure cover as described in "Removing and Replacing the Cover" on page 9.

With the cover removed, you can drop M4 or #6 screws into any of the four holes used for mounting the cover. The tips of the screws will emerge through holes in the back of the Song Meter and can be screwed into the fixed object. When the cover is replaced, the plastic cover fasteners will cover the heads of the mounting screws.

There are many possible mounting solutions. You could drop #6 wood screws into the four holes and screw them into a piece of plywood which, in turn, could be easily mounted to a tree or post. Or, you could drop #6 machine screws using wing nuts on the back to secure a wire or chain. The appropriate sized eyebolts could also be attached in a similar manner.

Waking Song Meter

Song Meter is designed to remain in a deep sleep between recording events and must be manually awoken in order to view or change the recording schedule or settings.

The SM2+ can be awoken by pressing the "Wake/Exit" button. The "Wake/Exit" button causes the SM2+ to wake up preserving any advanced scheduling state so that a schedule-in-progress can be resumed where it left off.

When the Song Meter wakes up, the display will show something like the following:

```
2011-Sep-16 13:32:56
Song Meter II R3.1.0
A: 32G 48%B: 32G  0%
C:  N/A   D: N/A
```

The top row displays the current date and time and is updated every second.

The bottom two rows display the status of the four SD flash memory card slots labelled "A" through "D".

If no SD flash card is plugged into a slot, "N/A" is displayed to indicate that the slot is not available.

Otherwise, its capacity in gigabytes and percent full are displayed. In the above example, slots A and B each have a 32GB card installed with A at 48% full and B empty at 0% full, and slots C and D have no card installed. Note that the write-protected status of the switch on the flash card is ignored, data will be written regardless of position. If a problem occurred while scanning a card, "ERROR" will be displayed.

Pre-Deployment Checklist

Please follow these recommended procedures to ensure a trouble free deployment. If you have any questions, you can contact us at www.wildlifeacoustics.com.

1. Inspect the Song Meter for damage inside and out. Verify that the three input connector nuts (left and right microphone inputs and external power input) are finger tight and that the weatherproof vent is also finger tight by turning clockwise. Never turn the nuts or vent counter-clockwise. Also verify that the cable gland is well seated and not punctured.
2. Install four fresh high-quality alkaline or properly charged NiMH D batteries in the main battery tray. Using your fingers, roll the batteries in-place to ensure good contact. Prior to installation, we recommend that you test the batteries with a high quality pulse load battery tester such as the ZTS MINI-MBT. Always remove flash cards prior to inserting or removing batteries to avoid damage to the card connectors.
3. Test and replace the 2 AA clock batteries annually.
4. Check to make sure that the date and time are set correctly and the clock is running.
5. Check to make sure you have the latest version of firmware by visiting the downloads section of our website.
6. Check the Zorb-It® packet installed on the inside cover. If it is noticeably swollen, it may have been exposed to liquid water and should be replaced. For more information, visit www.zorb-it.com.
7. After installing flash cards and microphones, use the instant record feature to make a test recording, and listen to the test recording to verify your audio settings are set as intended. See "Manual Recording Feature" on page 46.
8. In hot environments, avoid exposing the Song Meter to direct sunlight to ensure that the inside temperature does not exceed the rated limits of the Song Meter or batteries.

---

9. When you put Song Meter to sleep with the Wake/Exit button, make sure it indicates the expected wake-up time.
10. Make sure the indicator LED is flashing once per minute when sleeping or once per second while recording before walking away.

Configuration

Using the Song Meter Configuration Utility

All of the Song Meter settings and recording schedule can be configured directly on the Song Meter using the display and buttons as described throughout this manual. As a convenience, you may also create, view, or edit Song Meter configuration files using the *Song Meter Configuration Utility* application software. This software is available at no charge from the Wildlife Acoustics website at *http://www.wildlifeacoustics.com/*.

The Song Meter Configuration Utility also comes with sample configuration files that may already fit your needs for a variety of applications.

Menu Navigation

After waking the Song Meter, press the "Select" button to enter the main menu. The display will look like this:

```
Song Meter Main Menu
- Schedule (daily)
=
- Settings
- Utilities
```

By convention throughout this manual, the box above shows the contents of the 20 column by 4 row display. The double underline indicates the blinking cursor position. Each menu screen can only display three lines at a time. Any lines shown below the box can be seen by scrolling down using the "Down" button.

The "Up" and "Down" buttons can be used to scroll through the menu choices. To select a menu choice, press the "Select" button. To return to the previous menu, press the "Back" button. From the main menu above, you can press the "Back" button to return to the start-up screen.

The "Wake/Exit" button will start or resume the recording schedule.

Viewing or Changing the Daily Recording Schedule

The Song Meter can be configured to follow a simple daily recording schedule (the default), or a more advanced recording schedule (discussed later).

From the main menu, scroll to the "Schedule" line. Note that the line indicates which scheduling mode is selected in parentheses e.g. "(daily)" or "(advanced)". Press the "Select" button once to select the schedule mode. If necessary, you can then use the "Up" or "Down" buttons to toggle the scheduling mode between daily and advanced. Select the daily schedule mode and press "Select" a second time. The display will look like this:

```
Schedule:    (HH:MM)
- Add new entry
=
```

If a recording schedule has already been programmed, the display will show one line for each recording entry as follows:

```
Schedule:    (HH:MM)
- @ 05:30 for 01:30
- @ 23:00 for 01:00
- Add new entry
```

In the example above, there are two scheduled recording times, one from 5:30AM for an hour an a half and another at 11:00PM for an hour. Note that there can be up to 128 different scheduled recording times. If there are more than three scheduled recording times, then only three will be displayed at a time with others scrolled off the screen.

You can use the "Up" and "Down" buttons to scroll through the schedule entries and the "Add new entry" line.

To make a selection, push the "Select" button.

Adding a New Scheduled Recording Time

Use the "Up" and "Down" buttons to scroll to the "Add new entry" line, and then press the "Select" button.

```
Schedule:     (HH:MM)
- @ 05:30 for 01:30
- @ 23:00 for 01:00
- @ 00:00 for 00:00
```

Notice that the "Add new entry" is replaced with "@ 00:00 for 00:00" with the cursor on the starting time hour.

Use the "Up" and "Down" buttons to select the closest hour to the desired start time, then press the "Select" button.

The cursor will now advance to the minutes portion of the starting time. Again, you can use the "Up" and "Down" buttons to change the minute (and hour) to the desired start time, then press "Select".

The cursor will now advance to the hours portion of the recording duration. Use the "Up" and "Down" buttons to select the closest number of hours and press "Select".

Finally, the cursor will advance to the minutes portion of the recording duration. Use the "Up" and "Down" buttons to select the minute (and hour) of the desired recording duration, then press "Select".

You can use the "Back" button to back up if you make a mistake.

Notice that you may not have any two recording periods that overlap. In fact, there must be at least a one minute gap between the end of one recording period and the beginning of the next. If you attempt to create a recording entry that violates this rule, the error message "OVERLAP! TRY AGAIN" will be displayed for 5 seconds.

Also note that the maximum file size for any individual recording is 2GB. If you specify a duration (times sample rate, times number of channels, times 2 bytes per sample) exceeding 2GB, the recording may be split into more than one file.

Changing an Existing Scheduled Recording Time

Use the "Up" and "Down" buttons to scroll to the entry you wish to change, and then press the "Select" button. The cursor will advance to the starting time hour. Follow the steps above to change the entry.

Deleting an Existing Scheduled Recording Time

Use the "Up" and "Down" buttons to scroll to the entry you wish to delete, and then press the "Select" button. Follow the steps above and set the recording duration to 00:00. This will cause the entry to be deleted.

Viewing or Changing Song Meter Settings

From the main menu, use the "Up" or "Down" buttons to scroll to the "Settings" choice and press the "Select" button to enter the settings menu. The display will look like this:

```
Song Meter Settings:
-Time and date
-Location
-Audio
-Sensors
```

The settings are organized into four groups as indicated. You can use the "Up" and "Down" buttons to scroll to the desired settings group and press "Select" again to enter a group-specific submenu.

Time and Date

Select "Time and date" from the settings menu. The display will look like this:

```
Time and date:
2011-Sep-16 03:00:39
-Solar  Sunrise/Set
Rise 05:52 Set 17:58
```

The current time and date are shown on the second line, and today's calculated sunrise/sunset times are shown on the bottom line.

Changing the Time and/or Date

To change the time and/or date, scroll to the second line and press the "Select" button. The cursor will select the year and you can change the year by pressing the "Up" and "Down" buttons. To continue, press "Select" again to select the month, day, hour, minute, and second. After changing the seconds, pressing "Select" one more time will lock in the new time and date. At any time, you can back up by pressing the "Back" button.

Changing the method of Solar Calculation

You can also change the method for sunrise and sunset calculations by scrolling down to the "Solar" line. Press "Select" and use the "Up" and "Down" buttons to scroll through the following choices:

- Sunrise/set   when the sun is just below the horizon

- Civil   when the sun is 6 degrees below the horizon

- Nautical   when the sun is 12 degrees below the horizon

- Astronomical   when the sun is 18 degrees below the horizon

For sunrise and sunset calculations, you will also need to configure your location (latitude and longitude) and timezone as described below.

Location Settings

From the settings menu, select "Location". The display will look like this:

```
Location Settings:
-Prefix
-Latitude      0.00 N
-Longitude     0.00 W
```
-Timezone UTC + 0:00

Filename Prefix

Song Meter lets you specify a filename prefix of up to 12 characters that will become part of the recording file names and can be used to uniquely label recordings made by each Song Meter (e.g. to designate a location and/or project). Recordings are saved in a "Data" folder on the flash card and have names of the form *Prefix_YYYYMMDD_hhmmss.wav,* where *Prefix* is the prefix specified here, *YYYY* is the year, *MM* is the month, *DD* is the day, *hh* is the hour, *mm* is the minute, and *ss* is the second at which the recording was started. The suffix ".wav" is used for uncompressed files, and ".wac" for the proprietary lossless audio compression WAAC format.

Log files are also saved in the "Data" folder and have names of the form *Prefix_Sensor-X.txt* where *X* is the card slot letter A, B, C or D.

The prefix may contain capital letters, numbers, and hyphens. Press the select button to advance to each position in the prefix, and then use the up and down arrows to select from among the possible characters. Press select one more time to mark the end of the prefix.

The default value is no prefix, in which case no *Prefix_* will be present in the recording file names.

Latitude

Latitude is one of the parameters used to calculate the actual time of sunrise and sunset for scheduling recordings relative to sunrise and sunset times. You can specify the latitude of the Song Meter's location on the globe in degrees north (N) or south (S) of the equator.

Longitude

Longitude is one of the parameters used to calculate the actual time of sunrise and sunset for scheduling recordings relative to sunrise and sunset times. You can specify the longitude of the Song Meter's location on the globe in degrees west (W) or east (E) of Greenwich.

Timezone

Timezone is one of the parameters used to calculate the actual time of sunrise and sunset for scheduling recordings relative to sunrise and sunset times. You can specify the local timezone (as used to set the

clock) in hours relative to UTC (Universal Time Coordinated). Half and quarter timezones (e.g. :00, :15, :30, :45) are also supported.

Note that Song Meter does not automatically adjust for daylight savings time. This is mostly because daylight savings time is determined by government action and not by nature, so we can not predict the start or end of daylight savings time as this in fact changes from time to time in different countries by their respective governments.

Audio Settings

From the settings menu, select "Audio". The display will look like this:

```
Audio Settings:
-Sample rate   16000
-Channels      Stereo
-Compression      Off
```
```
-Gain left  + 0.0 dB
-Gain right + 0.0 dB
-Advanced settings
```

Sample Rate

Song Meter supports the following sample rates (in samples per second):

- 384,000 (available with the SM2BAT+ card)

- 192,000 (available with the SM2BAT+ card)

- 96,000

- 48,000

- 44,100

- 32,000

- 24,000

- 22,050

- 16,000

- 8,000

- 4,000

The default value set by the factory is 16,000 samples per second.

Channels

Song Meter can record in Stereo (both left and right channels) or Mono (using either the left or right channel). The default value set by the factory is two-channel stereo recording. Note that the SM2BAT+ can only record in mono using 384kHz sample rate.

Gain

The Song Meter audio path has three gain stages for amplification of the microphones on each channel. The first two stages are configured by the switches as described in "Amplifier Configuration Switches" on page 6. The third stage can be configured independently for each channel from between + 0.0 dB and + 12.0dB in 1.5 dB increments. The default value set by the factory is + 0.0 dB for both channels.

Note that the third stage gain has no effect on ultrasonic recordings made by SM2BAT+ daughter cards at sample rates of 192kHz or 384kHz.

Compression

Song Meter can compress audio files to increase storage capacity. By default, compression is turned off and the audio files are stored as uncompressed ".WAV" files. If compression is turned on, Song Meter will instead store audio files using the proprietary Wildlife Acoustics Audio Compression (WAAC) file format ".WAC" files. The SM2+BAT+ also offers a special zero crossing format described below.

The WAC0 format is a lossless audio compression format designed to provide efficient compression for typical open microphone field recordings. On average, ".WAC" files will be 60% the size of uncompressed ".WAV" files. Actual compression rates will vary depending on the sounds picked up by the microphones.

The WAC1-8 formats are lossy compression formats in which the least significant 1 to 8 bits of the 16-bit audio samples are dropped,

respectively. In most cases, the amplified self-noise of the microphone is well above the -87dBV (rms) full-scale represented by 16-bit audio samples such that the lower bits generally contain only random noise and no detectable information. For SMX-II microphones at +48dB gain, the noise floor is typically above the least significant 5 bits so that the WAC5 format can be used without any detectable loss of information and improving compression ratios to about 5:1.

To calculate the noise floor of a microphone in dBVrms, take the sensitivity in dBV/pa, subtract the SNR in dB, and add the gain in dB. For example, an SMX-II with sensitivity of -40dBV/pa and an SNR of 63dB amplified by +48dB has a noise floor of -40 - 63 + 48 = -55dBVrms. From r ms, convert to peak-to-peak by increasing dynamic range another 9dB, or -64dBVp-p. Each bit represents a dynamic range of about 6dB, so the significant bits above the noise are 64/6 = 10.6. So we can keep 11 and drop 5 of the 16-bits using the WAC5 format without a significant loss of signal clarity.

The SMX-US microphone at high frequencies (e.g. near 100kHz) has a noise floor down at -125dBVrms (that's about -50dBV sensitivity with a 75dB SNR). At +36dB gain, the noise floor is -89dBVrms or -98dBVp-p and can be resolved in 98/6 = 16.3 bits. So in this case, we need all the bits to maximize signal resolution. For this reason, we recommend WAC0 (lossless) compression for ultrasonic recording with the SMX-US microphone. At +48dB, WAC1 is acceptable.

Some additional processing power is required when compression is used resulting in an increase of power consumption.

Zero Crossing

If the SM2BAT+ daughter card is installed, an additional compression choice is available "ZC" for Zero Crossing. Refer to the SM2BAT+ supplement for more information.

Advanced Settings

The advanced settings sub-menu looks like this:

```
Advanced Settings:
-Dig HPF Left     Off
-Dig HPF Right    Off
-Dig LPF Left     Off
```

```
-Dig LPF Right    Off
-Trg Lvl Left     Off
-Trg Lvl Right    Off
-Trg Win Left    2.0s
-Trg Win Right   2.0s
-Div Ratio         16
```

The first four lines configure optional per-channel digital band-pass filters to filter out frequencies below the high-pass filter (HPF) and above the low-pass filter (LPF). The corner frequencies of these filters are configurable to the sample rate divided by either 3, 4, 6, 8, 12, 16, 24, 32, 48, 64, or 96.

The next four lines configure optional per-channel triggers. When triggers are enabled, recording is suspended until a trigger event is detected. Recording then continues until no trigger event is detected for the specified period of time between 0.1 and 9.9 seconds (default 2.0 seconds). For .WAV files (e.g. no compression), individual .WAV files are created for each triggered event. For .WAC files, highly compressed zero-value frames are stored in the recording independently preserving elapsed time between triggered events in a continuous .WAC file.

There are two kinds of triggers. Adaptive triggers are configured between +1 and +88 dB SNR and indicate a threshold level above the rolling average background spectrum within the frequency band selected by the band-pass filters. A +6dB trigger works fairly well for most cases. A higher value will be less sensitive and a lower value will be more sensitive.

The second kind of trigger is an absolute threshold between -1dB and -88dB full scale rms of the total energy in the frequency band selected by the band-pass filters.

".WAC" files can be read by our Song Scope software. Additionally, we provide a free cross-platform ".WAC" to ".WAV" (wac2wav) conversion program available from our website at:

http://www.wildlifeacoustics.com/downloads/

Finally, for SM2+s equipped with the SM2BAT+ ultrasonic sample rate boards, the "Div Ratio" option sets the frequency divider used for headphone output when listening to ultrasonic signals in realtime. The default value is 16. This setting is not displayed unless an ultrasonic board is installed.

Sensor Settings

The Song Meter has two sensor ports including a built-in temperature sensor (port zero) and an optional external sensor connected to the sensor port connector (port one).

The Song Meter can take a voltage measurement on either sensor port with 10-bit resolution. The voltage range is 0-3.3V with a resolution of 3.2 millivolts.

Each sensor can be configured and/or calibrated to translate a voltage reading into meaningful units appropriate for the sensor.

These sensors can be configured and calibrated by selecting "Sensors" from the settings menu. The display will look like this:

```
Sensor settings:
0: (Linear        )
1: (Linear        )
 0:    22.4  1: 1.650
```

The middle two lines represent configuration for the two different sensor ports, and the bottom line displays the current display value for the two sensors.

By default, both sensor ports are configured on a "Linear" scale. Port zero is set up to use the built-in temperature sensor and automatically converts voltage levels to degrees celsius as displayed on the bottom line and in the sensor logs. Port one is set up by default to display the actual voltage level as measured on the external sensor port. The value is not deterministic if no external sensor is connected.

In addition to a linear scale, a Steinhart-Hart scale is also supported for precision thermistor temperature sensors. The Steinhart-Hart equation is a slightly non-linear curve that more accurately models actual thermistor response to temperature thus making more accurate readings possible.

When you select on one of the two sensor ports, you can then use the up and down buttons to toggle between Linear and Steinhart-Hart modes. Press select again to configure the Linear or Steinhart-Hart parameters for your particular sensors.

When configuring a linear sensor, the display looks like this:

```
Sensor 0 (Linear   )
- Zero @  0400.00 mV
- Scale 1/0019.50 mV
- Precision 1 digits
```

The first setting represents the offset, in millivolts, representing zero units. For example, the built-in temperature sensor on port 0 measures 0 degrees C at 400 millivolts.

The second setting represents the scale, in millivolts, representing one unit. For example, the built-in temperature sensor on port 0 represents each degree C as a difference of 19.5 millivolts.

The third setting represents the precision of the resulting conversion. For example, we display the internal temperature sensor value with one digit to the right of the decimal point.

The sensors can then be calibrated for accuracy by adjusting these settings, and a variety of sensors can be supported.

When configuring a Steinhart-Hart sensor, the display looks like this:

```
Sensor 1 (Steinhart)
- Rs  100 x10^2 ohms
- A  1143 x10^-6
- B  2313 x10^-7
```
```
- C  1093 x10^-10
- D -7251 x10^-14
```

Rs represents a series resistor between the thermistor and ground and can be specified with a 3-digit mantissia and exponent. In this example, a 10,000 ohm series resistor is specified.

The other values A, B, C, and D represent coefficients of the Steinhart-Hart equation as follows:

$1/T = A + B (Ln Rt) + C (Ln Rt)^3 + D(Ln Rt)^5$

Where T is the temperature in Kelvin, Rt is the resistance of the thermistor, and A, B, C, and D are constants. When using the SM2++ with Steinhart-Hart sensors, the resistance is calculated with knowledge of the series resistor Rs, and then the temperature is calculated and converted to degrees celsius with one digit precision to the right of the decimal point.

Utilities

From the main menu, select "Utilities" to access a number of additional commands. The display will look like this:

```
Utilities:
-Go to sleep
-Load config from A:
-Save A:SONGMETR.SET
```
```
-Erase all cards
-Set factory default
```

Putting the Song Meter to Sleep

Selecting "Go to sleep" puts the Song Meter to sleep immediately. In this mode, the Song Meter will not wake up again until the "Wake/Exit" button is pressed or power is cycled by switching the Song Meter off and then on using the power switch. This is a convenient way of putting the Song Meter into a low power state for short-term transportation or storage and prevent it from automatically waking to make scheduled recordings. For long-term storage, it is better to move the power source selection switch to "off" to disconnect power entirely. See "Main Batteries and Power Selection Switch" on page 4.

Loading and Saving Configuration Files

The recording schedule and settings can be saved to or loaded from a *.SET* file on the flash card plugged into slot A. This feature is handy if you need to configure several Song Meters using the same schedule and settings. For example, you can configure one Song Meter and save the configuration, then load the same configuration on other Song Meters.

You can also use the *Song Meter Configuration Utility* application software to conveniently create or edit configuration files on your computer and visualize the recording schedule. **Note that by default, microphone gain settings, sensor settings and the prefix are not updated when you load settings.** The microphone gain settings and sensor settings may be calibrated to the tolerances of individual microphones and Song Meters, and the prefix is intended to uniquely identify each Song Meter in the field. However, you can override these parameters when using the *Song Meter Configuration Utility* application software.

To load a configuration file, select the "Load config from A:" selection from the utilities menu. The display will show a list of available *.SET* files present in the top directory of the flash card in slot A. You can then scroll through the list of files and select the configuration file you wish to load. The schedule and settings will be updated from the configuration file. To save a configuration file, select "Save A:SONGMETER.SET" from the utilities menu. This will save the schedule and settings to a file called *SONGMETER.SET* on the flash card installed in slot A.

Erase All Cards

You can permanently delete all the files on all flash cards to make room for new recordings. Select "Erase all cards" from the utilities menu. You will

be prompted to confirm this action. Scroll down to "Yes" and press the "Select" button. All flash cards will then be erased.

Setting Factory Defaults

Selecting "Set factory default" from the utilities menu causes all of the parameter settings to be set to the factory defaults and erases both the daily and advanced schedules.

Start Recording Schedule

Press the "Wake/Exit" button. If the next scheduled recording is more than 45 seconds away, the following message is displayed:
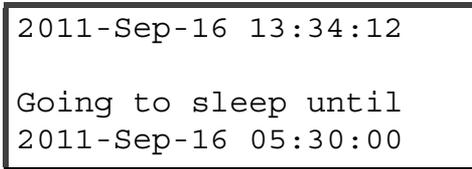
```
2011-Sep-16 13:34:12

Going to sleep until
2011-Sep-16 05:30:00
```

The top row indicates the current time and date. The bottom shows the next scheduled recording start time. After 5 seconds, the Song Meter will go into a deep sleep and the display will go blank. You should now replace the protective cover. See "Removing and Replacing the Cover" on page 9. The LED indicator light will blink once per minute for one second to indicate that the Song Meter is asleep and scheduled to wake up.

Note that if you are using an advanced schedule with AT_TIME, AT_SRIS, or AT_SSET commands, and the event has already happened (for example, waiting for sunset after the sun has already set), then the Song Meter will indicate it is going to sleep until tomorrow's event. If you intended to start the schedule based on today's event, you can press and hold the WAKE/EXIT button for one second while the above message is displayed. The display will then indicate "Backing up...". When you release the WAKE/EXIT button, the schedule resume as if you pressed the button 24 hours earlier.

If the next scheduled recording event is in progress or within 45 seconds away, then Song Meter will begin preparing to record and begin recording at the correct start time (or as soon as possible if a scheduled recording is already in progress).

If there were no scheduled recordings configured, the following message is displayed instead and Song Meter will go into a deep sleep until manually awoken:

```
2011-Sep-16 13:34:12

NO SCHEDULED EVENTS
Going to sleep......
```

Managing Power and Memory Resources

Recording time is limited by power and memory resources. Song Meter can only record while it still has sufficient power available in the batteries and while it has sufficient room to save recordings in the SD/SDHC flash cards. Download our free *Song Meter Configuration Utility* to see estimates of how long battery and memory resources are expected to last given your specific recording schedule and configuration.

Power Resources

The Song Meter SM2+ can run on 4 "D"-size Alkaline or rechargeable NiMH batteries. As a rule of thumb, you can expect to get about 12,000 milliamp hours out of a high quality set of Alkaline or NiMH "D" batteries., but this can vary significantly depending on how batteries are stored and charged, temperature, manufacturer, and other factors. There can even be significant variation between two different batteries from the same package. Also note that many NiMH rechargeable batteries self discharge at a rate of about 30% per month, although new low self discharge NiMH batteries are now available.

The SM2+ can also make use of an external power source using the optional SM2+ power adapter. The adapter contains a linear regulator providing 5V to the SM2+ and is designed to run on 6V and 12V DC inputs from larger batteries. The power adapter features overvoltage protection and reverse polarity protection. The adapter draws an additional 7 milliamps of current in both sleep modes and recording modes.

When the SM2+ is sleeping between scheduled recording events, it draws almost no measurable current (approximately 0.5 milliamps). While recording, current consumption depends on hardware options, sample rates, compression, filtering, triggering, and other factors.

The following tables illustrate typical SM2+ power consumption in a variety of configurations. You can use this information to estimate battery life.

For example, suppose your recording schedule is 5 minutes every hour at 24kHz in stereo with compression. When recording, according to the table below, you would expect to use 75mA of current. You should assume a little overhead for each recording because the SM2+ will wake up about 30 seconds early to scan the flash cards and prepare to record on time. So 5.5 minutes x 24 hours = 2.2 hours per day at 75mA or 165mA hours. In addition, the SM2+ would be sleeping for 21.8 hours each day at 0.5mA or another 11mA hours. So you can expect power consumption to be about 176mA hours per day. Given a battery with 12,000mA hour capacity, you could expect your schedule to run for about 68 days.

For another example, suppose you are recording bats using 384kHz triggered WAV recordings 10 hours per night. According to the tables below, the SMBAT+ uses165mA while waiting for triggers and 180mA while recording. With typical bat activity, you might be triggered 20% of the time and waiting for triggers 80% of the time. So, 80% x 165 + 20% x 180 = 168mA. Add another 10mA for the SMBAT+ daughter card, and you get 178mA per hour times 10 hours recording per day is 1,780mA hours per day. While sleeping for 14 hours per day x 0.5mA hours is an additional 7mA hour per day for a total of 1,787mA hours per day. Given a battery with 12,000mA hour capacity, this configuration could run for about 6.7 days.

Untriggered Recordings Power consumption in milliamps (add 10mA for SM2BAT+ if daughter card is installed)		
Sample Rate x Channels	WAV	WAC
4Kx1, 4Kx2, 8Kx1, 8Kx2	60	60
16Kx1,16Kx2	70	70
22.05Kx1, 22.05Kx2, 24Kx1, 24Kx2	65	75
32Kx1	85	85
32Kx2	85	90
44.1Kx1, 48Kx1	70	80
44.1Kx2, 48Kx2	70	95
96Kx1	65	100
96Kx2	85	115
192Kx1	80	110
192Kx2	110	145
384Kx1	85	150

Triggered Recordings Power consumption in milliamps		
Sample Rate x Channels, Compression	Wait for Trigger	Recording
192Kx1 WAV	75	95
192Kx1 WAC	115	125
192Kx2 WAV 384Kx1 WAV	100	130
192Kx2 WAC 384Kx1 WAC	175	190
ZC	35	35

Memory Resources

Song Meter has four SD/SDHC card slots. As of this writing, high capacity SDHC flash cards are available up to 32GB and SDXC up to 512GB. With four slots, the SM2+ has a capacity of 128GB using SDHC cards and 512GB using SDXC cards.

Recordings consume 2 bytes (16-bits) per sample, times the sample rate, times the number of channels per second. For example, a recording made at a sampling rate of 44,100 samples per second in stereo (2 channels) consumes 2 x 44,100 x 2 = 176,400 bytes per second. With 128GB total capacity, 128,000,000,000 divided by 176,400 = 725,623 seconds = 201 hours of recording time.

Note that the largest file size allowed for an individual recording is 2GB. You may need to adjust the duration of a given recording to fit within this limit. Otherwise, Song Meter will automatically break up the recording into pieces to satisfy this requirement.

In most applications, there is no reason to use sampling rates faster than twice the frequencies of interest. The majority of frog vocalizations are under 4KHz and need only be sampled at 8KHz while most bird

vocalizations are under 8KHz and need only be sampled at 16KHz (with the exception of some high-pitched warblers who sing at 10KHz and need to be sampled at greater than 20KHz).

The following tables illustrate the recording time in hours available for different combinations of total memory capacity, sample rates and channels. If you enable compression, you can almost double the capacity (compression rates vary with sample rates and site-specific ambient sound levels). For higher capacities using SDXC cards, simply multiply the 64GB row by the number of 64GB cards or multiply the 128GB row by the number of 128GB cards.

	Mono (1 channel)								
	96,000	**48,000**	**44,100**	**32,000**	**24,000**	**22,050**	**16,000**	**8,000**	**4,000**
8GB	11.6	23.1	25.2	34.7	46.3	50.4	69.4	138.9	277.8
16GB	23.1	46.3	50.4	69.4	92.6	100.8	138.9	277.8	555.6
32GB	46.3	92.6	100.8	138.9	185.2	201.6	277.8	555.6	1111.1
64GB	92.6	185.2	201.6	277.8	370.4	403.1	555.6	1111.1	2222.2
128GB	185.2	370.4	403.1	555.6	740.7	806.2	1111.1	2222.2	4444.4

	Stereo (2 channels)								
	96,000	**48,000**	**44,100**	**32,000**	**24,000**	**22,050**	**16,000**	**8,000**	**4,000**
8GB	5.8	11.6	12.6	17.4	23.1	25.2	34.7	69.4	138.9
16GB	11.6	23.1	25.2	34.7	46.3	50.4	69.4	138.9	277.8
32GB	23.1	46.3	50.4	69.4	92.6	100.8	138.9	277.8	555.6
64GB	46.3	92.6	100.8	138.9	185.2	201.6	277.8	555.6	1111.1
128GB	92.6	185.2	201.6	277.8	370.4	403.1	555.6	1111.1	2222.2

Viewing or Changing the Advanced Recording Schedule

This section describes the advanced scheduling mode of the Song Meter. By default, Song Meter is configured to use a simpler "daily" scheduling mode as described in "Viewing or Changing the Daily Recording Schedule" on page 16. The advanced scheduling mode can be selected from the main menu.Scroll to the "Schedule" line. Note that the line indicates which scheduling mode is selected in parentheses e.g. "(daily)" or "(advanced)". Press the "Select" button once to select the schedule mode. If necessary, you can then use the "Up" or "Down" buttons to toggle the scheduling mode between daily and advanced. Select the advanced schedule mode and press "Select" a second time.

Advanced Recording Commands

When the Song Meter is configured to use advanced scheduling, the schedule is defined as a sequence of simple commands. Each command is numbered sequentially with up to 99 commands in a recording program. **Warning: When the last command of the advanced schedule is executed, the program will end. If you want to repeat the schedule, you must include a GOTO LINE command at the end of your program.** It is always a good idea to use the *Song Meter Configuration Utility* to verify that advanced schedules will work as expected.

There are several types of commands as follows:

AT TIME hh:mm:ss

The "At Time" command is used to cause Song Meter to wait until the specified time of day. If possible, Song Meter will put itself to sleep until just before the scheduled time. Song Meter will wake up about 30 seconds early to take into account preparation time so that subsequent recordings begin at the specified time.

AT SRIS-hh:mm:ss

The "At Sunrise" command is used to cause Song Meter to wait until the specified amount of time before the next occurring sunrise. See "Solar Tracking" on page 40 for details.

AT SSET-hh:mm:ss

The "At Sunset" command is used to cause Song Meter to wait until the specified amount of time before the next occurring sunset. See "Solar Tracking" on page 40 for details.

RECORD hh:mm:ss

The "Record" command is used to cause Song Meter to record for the specified duration. If a zero duration is specified, no audio recording will be made. However, the internal temperature sensor and external sensor port will be read and logged to the sensor log file.

Note that the maximum file size is 2GB. You should make sure that the specified duration (times sample rate, times number of channels, times 2 bytes per sample) is less than this 2GB limit. Otherwise, the recording will be split into multiple recordings.

PAUSE hh:mm:ss

The "Pause" command is used to cause Song Meter to wait for the specified duration. If possible, Song Meter will put itself to sleep until about thirty seconds before the end of the pause. Additionally, Song Meter will take into consideration any delays in finishing and saving the previous recording such that the delay begins when the previous recording ended, not when the previous recording was saved. We recommend a pause of at least 30 seconds to give Song Meter enough time to finish a previous recording and prepare for a subsequent recording.

Note that sequential "Pause" and "At Time" commands may be consolidated by Song Meter. For example, consider the following sequence:

```
AT TIME 05:00:00
PAUSE   01:00:00
```

When Song Meter comes across the sequence above, it will sleep until just before 06:00AM without waking up at 05:00AM.

GOTO LINE aa bbX

The "Goto Line" command is used to create programable loops (which may be nested). If "bb" is zero, the loop is always taken and the next command to be executed will be line "aa". Otherwise, the loop to line "aa" will be executed "bb" times. After "bb" loops, Song Meter will continue with the commands immediately following the "Goto Line" command.

Be careful to avoid unwanted infinite loops. If Song Meter detects an infinite loop while running, it will abandon the program and go to sleep until awoken manually.

When inserting or deleting commands from the program, Song Meter will automatically adjust the "Goto Line" command line numbers referenced.

SET rrrrrXccccccc

The "Set" command is used to change the recording settings to use the sample rate specified by rrrrr and the number of channels specified by cccccc. These settings will be used until the next "Set" command, or until the program is restarted. When an advanced schedule program is first started, the initial settings specified by the settings parameter menu are used.

DO

The DO command starts a DO...UNTIL block as defined by a sequence of RECORD, PAUSE, GOTO LINE, or SET commands followed by either an "UNTTIME, UNTSRIS+, or UNTSSET+ command. These UNTIL commands specify an ending time for the block.

After the DO command, the advanced schedule program will continue normally. However, if the ending time is reached, any recording in progress will be truncated and the advanced schedule will skip ahead to the command following the UNTIL command.

If the UNTIL command is reached before the ending time, the schedule will wait for the ending time before continuing.

DO...UNTIL blocks may not be nested.

GOTO commands within the DO...UNTIL block should not jump out of the DO...UNTIL block.

AT TIME, AT SRIS- and AT SSET- commands should not be used inside a DO...UNTIL block.

UNTTIME hh:mm:ss

The "Until Time" command ends a DO...UNTIL block and specifies a specific ending time of day.

UNTSRIS+hh:mm:ss

The "Until Sunrise" command ends a DO...UNTIL block and indicates an ending time as the specified amount of time after the next occurring sunrise.

UNTSSET+hh:mm:ss

The "Until Sunset" command ends a DO...UNTIL block and indicates an ending time as the specified amount of time after the next occurring sunset.

Advanced Recording Example

Consider the following example:

```
01 AT TIME 05:30:00
02 RECORD  00:30:00
03 PAUSE   01:00:00
04 RECORD  00:01:00
05 PAUSE   00:09:00
06 GOTO LINE 04 10X
07 PAUSE   01:00:00
08 GOTO LINE 04  1X
09 GOTO LINE 01  0X
```

In the above example, a fairly complex schedule is defined in only 9 commands.

First, look at lines 01 and 02 in the example. Song Meter will wait until 5:30AM and record for 30 minutes (5:30-6:00AM).

Next, in line 03, Song Meter will wait for an hour (7:00AM), and then (line 04) record for one minute (7:00-7:01AM), and then (line 05) wait for 9 minutes (7:10AM).

Now look at line 06. The "Goto Line" command will go back to line 04 and repeat line 04 and 05 10 times. This will cause ten one-minute recordings to be made every 10 minutes at 7:10, 7:20, 7:30, 7:40, 7:50, 8:00, 8:10, 8:20, 8:30, and 8:40AM. The pause in line 05 added to the one minute recording causes Song Meter to wait until 8:50AM before reaching the "Goto Line" command on line 06 for the 11th time (after the 10th loop). Song Meter will now continue processing at line 07.

Next look at line 07. Song Meter will wait for an hour (9:50AM).

On line 08, another "Goto Line" command will cause lines 04 through 07 to be run one more time. This will result in eleven more one-minute recordings to be made at 9:50, 10:00, 10:10, 10:20, 10:30, 10:40, 10:50, 11:00, 11:10, 11:20 and 11:30AM. The last pause on line 05 ends at 11:40AM, and the pause on line 07 ends at 12:40PM.

Finally, line 09 causes the program to run all over again from the beginning waiting until 5:30AM on line 01.

As you can see, this simple 9-line program is able to schedule 23 different recordings per day at various intervals and durations.

Configuring Advanced Recordings

From the main menu, scroll to the "Schedule" line. Note that the line indicates which scheduling mode is selected in parentheses e.g. "(daily)" or "(advanced)". Press the "Select" button once to select the schedule mode. If necessary, you can then use the "Up" or "Down" buttons to toggle the scheduling mode between daily and advanced. Select the advanced schedule mode and press "Select" a second time. The display will look like this:

```
Schedule: (Advanced)
-01 <Add/Insert>
=
```

If an advanced recording schedule has already been programmed, the display will show one line for each recording entry, for example:

```
Schedule: (Advanced)
-01 AT TIME 05:00:00
-02 RECORD  00:30:00
-03 PAUSE   01:00:00
-04 RECORD  00:01:00
-05 PAUSE   00:09:00
-06 GOTO LINE 04 10X
-07 PAUSE   01:00:00
-08 GOTO LINE 04  1X
-09 GOTO LINE 01  0X
-10 <Add/Insert>
```

To change or delete a line, use the up and down buttons to scroll to the desired line and press the select button. You can then use the up and down buttons to choose from different commands or to choose "<Delete>" to delete the line. Press the select button to confirm your choice and advance the cursor to any parameters to be modified. Continue using the select, up and down buttons to complete the command, or the back button to back up.

To add or insert a line, scroll down to the "<Add/Insert>" entry and press the select button. You may then use the up and down buttons to change the line number. By default, a new line is created at the bottom of the program. However, you can choose a different line number and the new line will be inserted above your choice. Press the select button to confirm the line number and continue as described above to choose the command and parameter values for the new line until it is complete.

Solar Tracking

Song Meter can be used to schedule recordings relative to actual sunrise and sunset times as they change according to the time of year and location on the globe. To use the solar tracking feature, the Song Meter's coordinates must be specified (see "Latitude" on page 20 and "Longitude" on page 20). In addition, the timezone used to set the clock must be specified relative to UTC (see "Timezone" on page 20).

Sunrise and sunset times are calculated according to when the sun rises or sets at the horizon. Alternatively, civil twilight (6 degrees below the horizon), nautical twilight (12 degrees below the horizon), or astronomical twilight (18 degrees below the horizon) can be specified. See "Changing the method of Solar Calculation" on page 19.

The advanced scheduling commands "AT SRIS" and "AT SSET" can be used to cause Song Meter to wait until some specified time before the next occurring sunrise or sunset respectively (see "AT SRIS-hh:mm:ss" on page 35 and "AT SSET-hh:mm:ss" on page 36). The following example advanced scheduling program would record daily for one hour beginning 15 minutes before sunrise, and another hour beginning 15 minutes after sunset:

```
01 AT SRIS-00:15:00
02 RECORD  01:00:00
03 AT SSET-00:00:00
04 PAUSE   00:15:00
05 RECORD  01:00:00
06 GOTO LINE 01  0X
```

The calculated sunrise and sunset times for the current day can be viewed by visiting the "Change time and date" menu. See "Changing the Time and/or Date" on page 19 for details.

Ending a Recording Schedule at a Specified Time

The DO...UNTIL commands described above can be used to end a recording schedule relative to sunrise, sunset, or a specific time of day.

For example, the following sequence will record 5 minutes every hour from 15 minutes before sunrise until 15 minutes after sunset daily:

```
01 AT SRIS-00:15:00
02 DO
03 RECORD 00:05:00
04 PAUSE 00:55:00
05 GOTO LINE 03 00X
06 UNTSSET+00:15:00
07 GOTO LINE 01 00X
```

Caveats and Implementation Details

The SM2+ remembers the program state when interrupted. This means that you can manually wake up the Song Meter in the middle of an advanced schedule to check status, and Song Meter will then resume the advanced schedule where it left off when you press the "Wake/Exit" button. To reset the schedule from the beginning, you can cycle power by turning the Song Meter off and then on again using the power switch. The schedule is also automatically reset if you make any changes to the schedule or other configuration parameters.

Making Recordings

Autonomous Operation

After configuring Song Meter as described in the previous chapter, pressing the "Wake/Exit" button will cause Song Meter to put itself to sleep until the next scheduled recording event.

Song Meter will automatically wake up about 30 seconds before the scheduled event to prepare. The start-up display will be as before:

```
2011-Sep-16 13:32:56
Song Meter II R3.1.0
A: 32G 48%B: 32G  0%
C:  N/A   D: N/A
```

After scanning the four SD flash card slots, the message "Preparing to record" will appear:

```
2011-Sep-16 05:29:11
Song Meter II R3.1.0
Preparing to record
```

Song Meter is now preparing itself to begin recording and will wait for the scheduled starting time to begin. Note that if a scheduled recording time is already in progress, Song Meter will begin recording as soon as it is ready to do so and end the recording on schedule. You can abort the next recording and return to the main menu by pressing the "Wake/Exit" button.

When Song Meter begins recording, the display will indicate progress as shown below:

```
2011-Sep-16 13:32:56
Recording:  01:29:12
B:0909111332.WAV  0%
44100xStereo      5%
```

The top line of the display shows the current date and time as before.

The second line indicates the time remaining in the current recording.

The third line shows the flash card slot and short file name of the recording file (*MMDDhhmm.WAV*) and the percent complete. Note that unique long file names are actually used on the flash card of the form *Prefix_YYYYMMDD_hhmmss.wav).*

The last line shows the sample rate and number of channels (x2 for stereo, x1 for mono), and the percentage indicates how full the SD flash card slot is on which the recording is being made.

You can press the "Select" button to toggle between the display above and the following. In this mode, the audio being recorded is also sent to the headphone jack so you can check levels.

```
2011-Sep-16 13:32:56
Recording:  01:29:12
L:***      -45.2dBV
R:****     -41.1dBV
```

The rms signal levels of each channel are shown both graphically (with each asterisk representing 6dB) and with an indication of signal level relative to 1Vrms full scale.

When making recordings at ultrasonic sample rates e.g. 192kHz or 384kHz, output to the headphones will be frequency divided by the specified Div Ratio in the advanced audio settings configuration.

Audio Files

Song Meter creates a file for each scheduled recording under a directory called *Data*. The file name indicates the actual start time of the recording and has the format *Prefix_YYYYMMDD_hhmmss.wav*, where *Prefix_* is a user-defined label (see "Filename Prefix" on page 20), *YYYY* is the year, *MM* is the month (00-12), *DD* is the day (00-31), *hh* is the hour (00-23) *mm* is the minute (00-59), and *ss* is the second (00-59). The file is a standard 16-bit PCM uncompressed ".WAV" file. For display purposes, Song Meter shows a shortened version of the filename on the LCD of the form *MMDDhhmm.WAV.*

If compression is enabled, files are stored in the Wildlife Acoustics Audio Compressionformat indicated by ".WAC" instead of ".WAV".

The filename is shown with an A:, B:, C:, or D: prefix indicating which SD flash card slot is being used. Song Meter will use the lowest lettered slot that is available and has sufficient remaining free space to store the recording. If there is no more room for recording in any slot, the following message will be displayed for 5 seconds, then Song Meter will go to sleep until manually awoken:

```
2011-Sep-16 05:29:11
Song Meter II R3.1.0
MEDIA FULL OR FAILED
Shutting down.......
```

Data Log Files

Song Meter creates one log file for each card with the name *Prefix_Sensor-X.txt*, where *X* is the card slot letter A, B, C, or D.

At the start of each recording, and every 5 minutes during recording, Song Meter takes a reading on the two sensors (the internal temperature sensor and the external sensor port). Each reading is appended on a line to the log file on the same card used to make the recording as follows:

```
2009-Oct-01      11:44:25   22.9  1.408
```

The four tab-delimited fields include the date, time, internal temperature, and external sensor readings. For scale and calibration information, see "Sensor Settings" on page 25.

Aborting a Recording in Progress

While the Song Meter is recording, you can press the "Back" or "Wake/Exit" to abort the recording in progress and enter the start-up screen.

Manual Recording Feature

In addition to recording on a schedule, the Song Meter can also start a recording when the start-up screen is displayed by pushing the "Up" and "Down" buttons simultaneously. This will start a one-hour recording on the lowest lettered slot on which the recording will fit.

Pressing the "Select" button toggles between display modes and headphone output as described in the previous section.

Song Meter Specifications

Physical Specifications

- Dimensions: 8.0" X 8.0" X 2.5"

- Weight: 1.5 pounds without batteries

- Enclosure: NEMA Type 1,4,4X and 6 (weatherproof, vented). A self-regenerating humidity control device such as Zorb-It is required to prevent condensation in some conditions.

- Operating Temp.: -4ºF to +185ºF   -20ºC to +85ºC (Inside the enclosure - avoid exposure to direct sunlight in hot environments. Also note that operating range of the batteries used may be narrower.

Audio Specifications

- ChannelsChannels:2

- Interface: 3-pin waterproof connector (ground, signal, 3.3V supply)

- Bias power: 2.5V 2.2K ohm, switch enabled per channel

- High-pass filter: 2-pole butterworth,switch selectable per channel at 2, 180 or 1,000Hz

- Pre-amplifier: 2-stage, switch selectable per channel, at +0, +12, +24, +36, +48, or +60dB gain. For sample rates <= 96kHz, third-stage digitally-configurable +0-+12dB in 1.5dB steps

- Noise: -115dBV equivalent input noise (-105dBV for 192kHz and 384kHz sample rates)

- ADC: 1V rms full-scale 16-bit, 90dB SNR

- Sample rates: 4, 8, 16, 22.05, 24, 32, 44.1, 48kHz and 96kHz standard; 192kHz and 384kHz available with SM2BAT+ daughter card.

- Digital format: 16-bit .WAV PCM (optional .WAC proprietary lossless or lossy compression formats) or zero crossing.

- Headphones: 3.5mm stereo jack

- Filtering and triggering: Configurable digital high-pass and low-pass filters at sample rate divided by 3, 4, 6, 8, 12, 16, 24, 32, 48 and 96. Adaptable trigger with configurable threshold above background 1-88dB, absolute trigger with configurable threshold -1 - -88dB full scale, inactivity time for trigger off 0.1 - 9.9 seconds.

Sensors

- Channels: 2

- ADC: 10-bit at 3.3V reference (3.2millivolt resolution)

- Parameters available for precise calibration

- Internal temperature sensor accurate to within ±2ºC at 0ºC.

Storage

- 4 SD/SDHC/SDXC flash card slots (Class 4 or greater)

- 128GB total capacity with 4x32GB SDHC cards and 512GB total capacity with 4x128GB SDXC cards

- Compression increases effective capacity by 60-70% typically

Power

- 4-10VDC main power (internal 4 D-size batteries or external weatherproof connector)

- 6-20VDC through external power adapter for 6 or 12V solar power systems

- < 1mA current draw when idle between scheduled recordings

- *The following estimates can vary 10mA depending on flash cards used:*

- 60-85mA when recording uncompressed up to 96kHz sample rate

- 60-115mA when recording compressed up to 96kHz sample rate

- 75mA when recording uncompressed and triggered at 192kHz mono

- 115-175mA when recording uncompressed and triggered at 192kHz stereo and 384kHz

- 95mA when recording compressed and triggered at 192kHz mono

- 125-190mA when recording compressed and triggered at 192kHz stereo and 384kHz

- 25mA in ZC mode on SM2BAT+

- Separate power for time-of-day clock uses 2 AA-size batteries, < 0.1milliamps (2-3 year service life)

Expansion Options

- External air/soil/water temperature sensor option

- GPS time synchronization option

- Field-upgradeable firmware

SMX-II Microphones

- Enclosure: weatherproof

- Sensitivity: -36±4dB (0dB=1V/pa@1KHz)

- Frequency response: flat 20Hz - 20,000Hz

- Signal-to-Noise Ratio: > 62dB

- Directionality: Omnidirectional

Warranty

Wildlife Acoustics Inc. Limited Warranty

HARDWARE: Wildlife Acoustics, Inc. ("WAI") warrants to the original end user ("Customer") that new WAI branded products will be free from defects in workmanship and materials, under normal use, for one (1) year from the original purchase date. WAI warrants refurbished WAI products, marked and sold as such, for ninety (90) days from the original purchase date.

SOFTWARE: WAI warrants to Customer that any WAI branded software will perform in substantial conformance to their program specifications for a period of ninety (90) days from the date of original purchase. WAI warrants the media containing software against failure during the warranty period. WAI makes no warranty or representation that the operation of the software products will be uninterrupted or error free, or that all defects in the software products will be corrected.

EXCLUSIONS

This warranty excludes (1) physical damage to the surface of the product, including cracks or scratches on the outside casing; (2) damage caused by misuse, neglect, improper installation or testing, unauthorized attempts to open, repair, or modify the product, or any other cause beyond the range of the intended use; (3) damage caused by accident, fire, power changes, other hazards, or acts of God; or (4) use of the product with any non-WAI device or service if such device or service causes the problem.

Any third party products, including software, included with WAI products are not covered by this WAI warranty and WAI makes no representations or warranties on behalf of such third parties. Any warranty on such products is from the supplier or licensor of the product.

EXCLUSIVE REMEDIES

Should a covered defect occur during the warranty period and you notify WAI, your sole and exclusive remedy shall be, at WAI's sole option and expense, to repair or replace the product or software. If WAI cannot reasonably repair nor replace then WAI may, in its sole discretion, refund the purchase price paid for the product. Replacement products or parts may be new or reconditioned or comparable versions of the defective item. WAI warrants any replaced or

repaired product, part, or software for a period of ninety (90) days from shipment, or through the end of the original warranty, whichever is longer.

OBTAINING WARRANTY SERVICE: Customer should refer to WAI's website at www.wildlifeacoustics.com/support for information on obtaining warranty service authorization. Methods for obtaining warranty service may vary depending on whether purchases were made from an authorized provider of WAI products, or from WAI directly. All requests for warranty service authorization must be made within the applicable warranty period. Dated proof of original purchase will be required. Products or parts shipped by Customer to WAI must be sent postage-paid and packaged appropriately for safe shipment. WAI is not responsible for Customer products received without a warranty service authorization and may be rejected. Repaired or replacement products will be shipped to Customer at WAI's expense. All products or parts that are replaced become the property of WAI. WAI shall not be responsible for Customer's software, firmware, information, or memory data contained in, stored on, or integrated with any products returned to WAI for repair, whether under warranty or not. The repair and replacement process for products or parts in locations outside of the United States will vary depending on Customer's location.

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Warranty
Wildlife Acoustics Inc. Limited Warranty

OR REFUND OF THE PURCHASE PRICE PAID, AT WAI'S OPTION. IN NO EVENT SHALL WAI'S LIABILITY FOR ALL DAMAGES RELATED TO THE PURCHASE OF PRODUCT EXCEED THE AMOUNT PAID FOR THE APPLICABLE PRODUCT. THE FOREGOING LIMITATIONS WILL APPLY EVEN IF THE ABOVE STATED REMEDY FAILS OF ITS ESSENTIAL PURPOSE.

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GOVERNING LAW: This Limited Warranty shall be governed by the laws of the Commonwealth of Massachusetts, U.S.A., and by the laws of the United States, excluding their conflicts of laws principles. The United Nations Convention on Contracts for the International Sale of Goods is hereby excluded in its entirety from application to this Limited Warranty.

Wildlife Acoustics, Inc., P.O. Box 680, Concord, MA 01742-0680, United States of America, (888) 733-0200, www.wildlifeacoustics.com

Declaration of Conformity (EN 45014)

Manufacturer: Wildlife Acoustics, Inc.
970 Sudbury Road
Concord, MA 01742-0680
United States of America

Declares that the following product:

Product Name: Song Meter
Product Model Numbers: SM2+

Product Type: Digital Audio Field Recorder

Conforms to the appropriate country standards and governing regulations listed below. We, as the manufacturer, are fully responsible for the design and production of the above-mentioned equipment.

FCC:	United States Federal Communications Commission Rules Part 15, Class A
EN 55011: (2007)	Industry Canada, Interference-Causing Equipment Standard, Digital Apparatus, Class A
AS/NZS: (CISPR 11: 2007)	Australia/New Zealand Industrial, scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement, Class A
ICES-003: (2004)	Industry Canada, Interference-Causing Equipment Standard, Digital Apparatus
EN 61326: (1:2006)	Electrical Equipment for Measurement, Control and Laboratory Use EMC Requirements
EN 61000-4-2:	Electrostatic Discharge
EN 61000-4-3:	Radiated Electromagnetic Fields

Declaration of Conformity (EN 45014)

This class A digital apparatus also meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la Classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

This product operates on 6V DC.

This product was tested in a typical configuration.Note that there may be some undesirable recording quality when subjected to electromagnetic interference.

Ian Agranat, President
Wildlife Acoustics, Inc.
July 29, 2011