User Manual Supplement

Song Meter SM2M+ Submersible
Song Meter SM2M+ Deep Water

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ACOUSTICS
BIOACOUSTICS MONITORING SYSTEMS

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Introduction

The Song Meter SM2M+ Marine Recorder is a submersible 16-bit digital recorder designed for short or long term deployments in fresh or salt water.
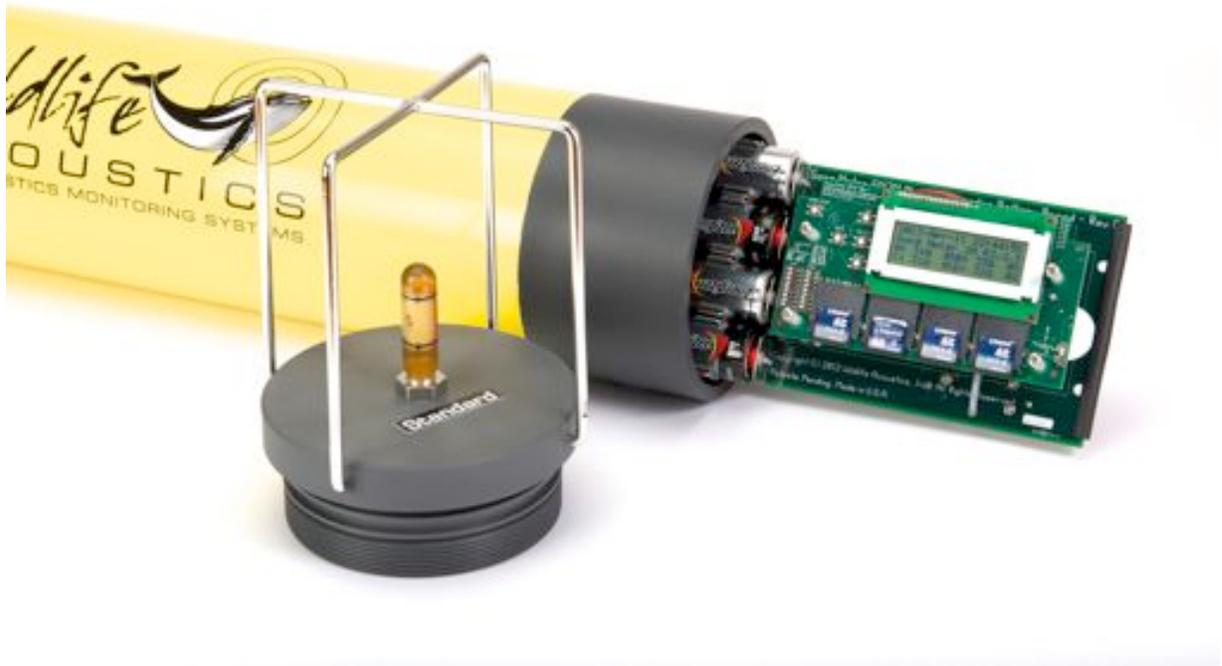
Like the terrestrial SM2+ recorder, the SM2M+ features flexible scheduling, extremely low power consumption, 16-bit digital recording and ease of use in a cost effective and easy to use package. The unit was designed to allow quick refurbishment of the device shipside for immediate redeployment. The batteries and SD flash cards can be easily swapped and the housing resealed for redeployment. The device can be anchored and recovered via tether, diver or optional acoustic release. A high quality case is included for storage and transportation.

Use of this Document

This document is a supplement to the Song Meter SM2+ User Manual. It is not intended as a stand-alone document and describes only information specifically related to the Song Meter SM2M+ Marine Recorder. The SM2M+ is built upon the SM2+ platform and that user manual should be read first to fully understand the devices features and capabilities.

You may want to download and install the Kaleidoscope conversion software and the Song Meter Configuration Utility software from the "downloads" section of our website at www.wildlifeacoustics.com.

Product Family Overview

Housing Options and Electronics

Two models are available: The Song Meter SM2M+ Submersible and the Song Meter SM2M+ Deep water. The only significant differences between the two units are depth rating and power capacity.

Song Meter SM2M+ Submersible uses a thick-walled PVC housing rated to 150 meters.

The Song Meter SM2M+ Deep water is rated to 1500 meters, which is achieved with a hard coat anodized and epoxy painted aluminum housing.

Both units use the same base electronics mother board that accepts 32 D cell batteries as shown in the photo below (more batteries are installed on the back of the board).

For the power capacity difference, the Deep Water unit has a second board attached to the motherboard. This second board also has a power cable that connects to the main motherboard and provides an additional 32 D cell capacity for a total of 64 D cell batteries, or twice the capacity of the SM2M+ Submersible unit.

Hydrophone Options

High-SPL   Standard   Ultrasonic   Low Noise   Dual Configuration Top Cap

Hydrophones	Frequency Range (Hz)	Dynamic Range (dB SPL)
Standard Acoustic	2 – 48,000	78 - 165
Ultrasonic	2 – 192,000	81 - 165
Low-Noise	2 – 48,000	56 - 165
High-SPL (Dual Config with Standard)	2 – 48,000	78 - 240

The Standard Acoustic hydrophone is used to record whale songs, dolphin whistles, and/or ambient noise levels, from infrasonic into ultrasonic frequencies.

With the Ultrasonic upgrade, additional circuitry and the Ultrasonic hydrophone increases the recording bandwidth of the system to allow recordings not only from ultrasonic dolphin and porpoise echolocation calls, but also ultrasonic anthropogenic sounds as well.

The low-noise hydrophone is for recording ultra-quiet environments such as remote marine sanctuaries, deep-water locations or long-range, offshore sites. It has the lowest noise floor of all the hydrophones with its self-noise being well below sea state 0 over its entire recording bandwidth. (See the self-noise chart on the following page).

The High-SPL is specifically tailored to recording and quantifying high sound pressure levels such as those produced by pile drivers

and air guns. When combined with any of the other hydrophones in a dual hydrophone configuration, the unit can record quiet or distant sounds from any source including marine life with one hydrophone, and at the same time accurately record and quantify very loud sounds from anthropogenic sources with the High-SPL.

The sensitivity of each hydrophone is calibrated to a .1 dB resolution by the hydrophone manufacture. This value will be on a tag attached to the hydrophone cable and is reported as the average value over the band from 200Hz to 1.6 kHz in 100Hz steps. From the frequency response below you can extrapolate sensitivity across the rest of the frequency range with some degree of accuracy, as they are quite consistent in response.

Hydrophone Options Frequency Response

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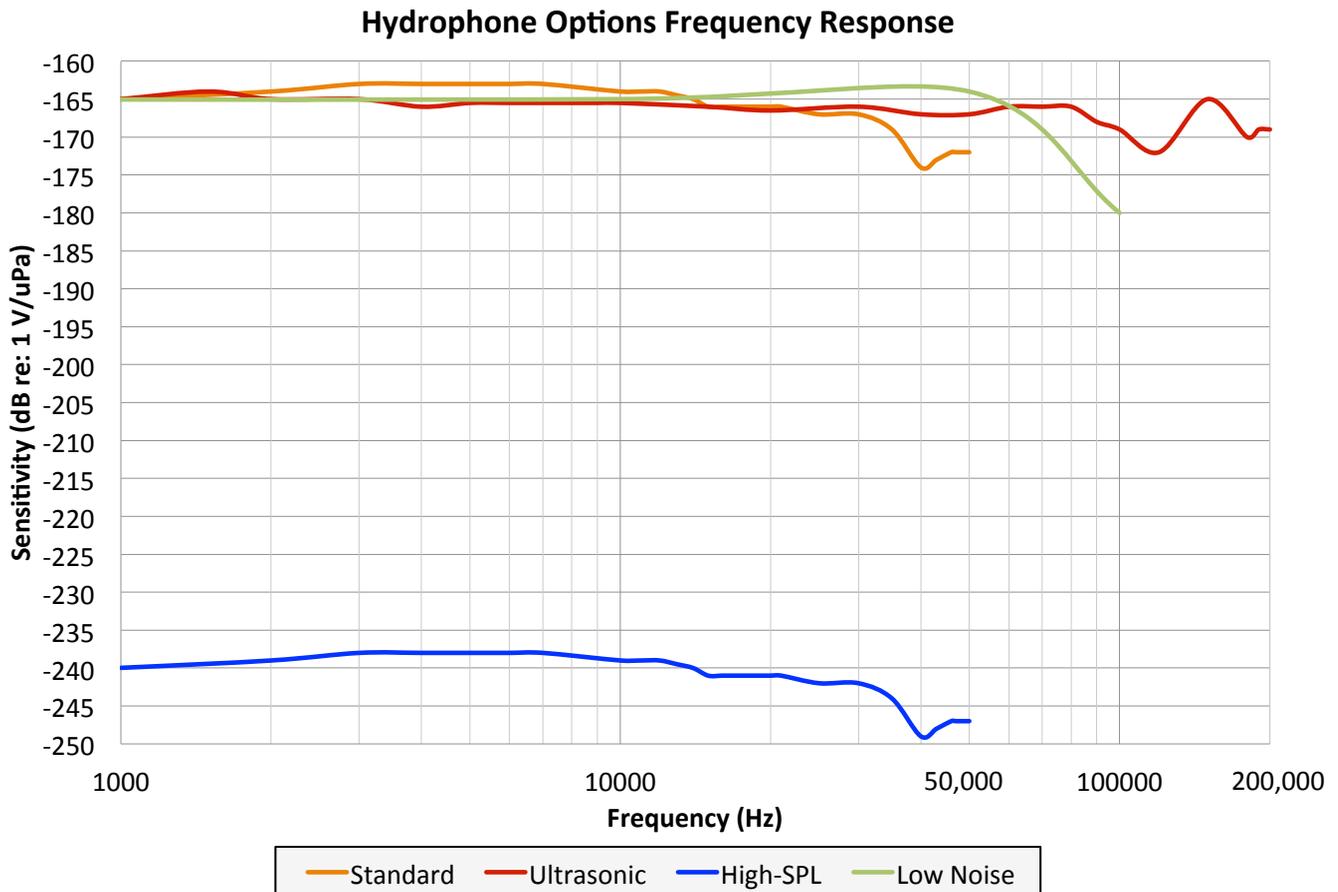
In the following chart you can see the self noise of the hydrophone options as related to different sea states.

Hydrophone Options Self Noise
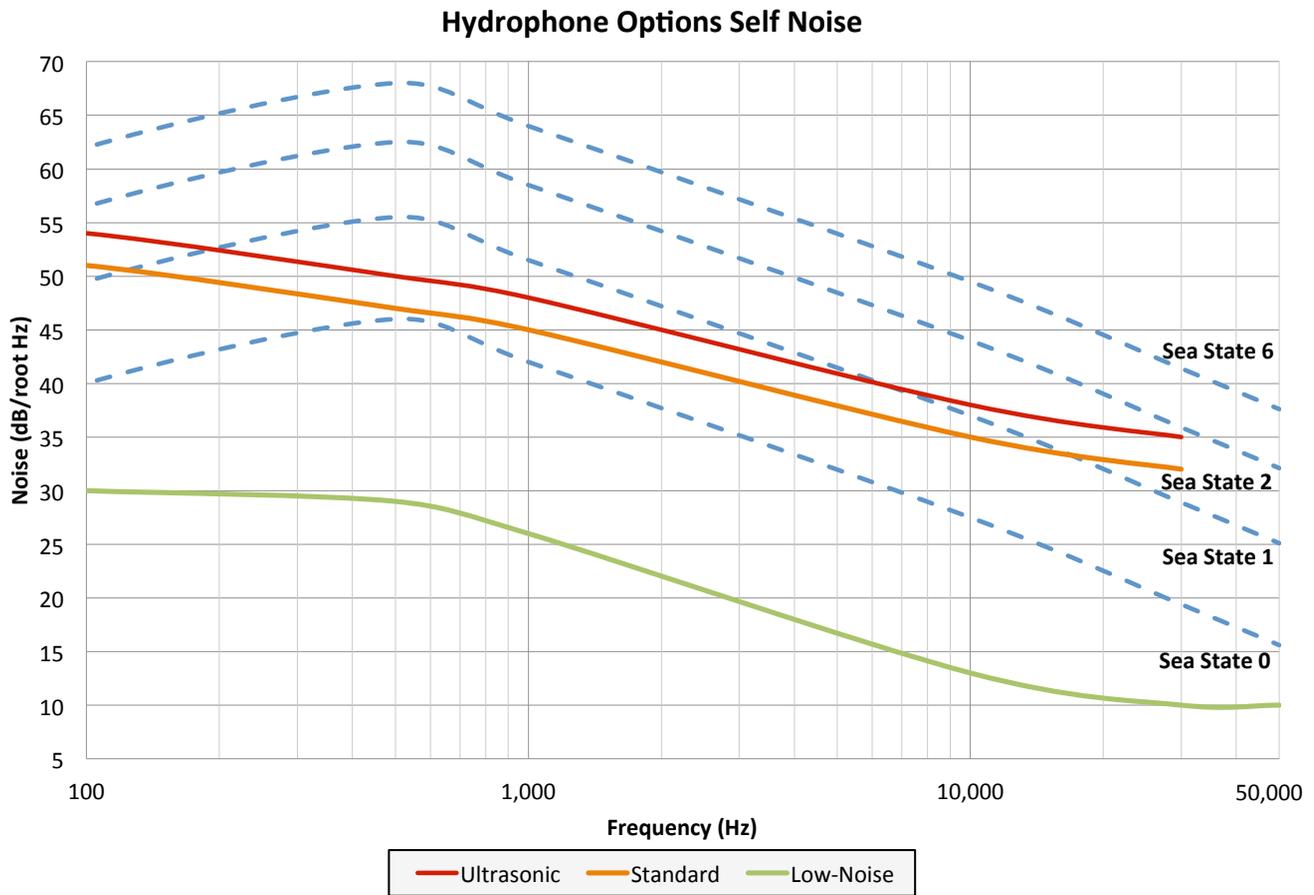
Electronics Setup

Switch Settings

High pass filter selection is dependent on the desired recording bandwidth. To capture low frequencies to the limit of the hydrophones sensitivity, 3Hz should be selected.

For the Standard, Low-Noise and Ultrasonic Hydrophones, a good starting point for gain is 12 dB, this will be optimal for recording distant marine mammals or quantifying ambient conditions. If the unit is near louder anthropogenic noise sources, 0dB might be more suitable to avoid clipping.

For the High SPL hydrophone Option when combined with the standard hydrophone, 0dB gain on both channels will assure that sounds can be recorded from about 78dB SPL all the way up to 240dB SPL. There is no reason to use additional gain as both hydrophones are fully covering the available dynamic range. Further gain will not allow recording quieter sounds due to the self-noise of the standard hydrophone.

Test recordings are encouraged to select the optimal gain. Except in a dual hydrophone configuration, the unit is shipped with both Song Meter channels connected to the single hydrophone, so it is also possible to record both channels with two different gain and filter settings.

The 2.5V Mic Bias switch should be set to "off", this risks damage to the hydrophone.

The Power Source switch should be set to internal to power the device. External power is not wired so the unit is off when the switch is in the external position.

Audio Settings

The audio settings are covered in depth in the Song Meter SM2+ User Manual. The SM2M+ allows sample rates from 4kHz to 96kHz and up to 384kHz with the Ultrasonic Upgrade. To choose an appropriate sample rate, always at least double the highest frequency that you wish to record.

Recordings can be made in standard WAV format or in WAC, Wildlife Acoustics' lossless compression format. WAC0 will use

only about 60% of the card space to better minimize card usage for longer deployments. The files can be converted to WAV format quickly and easily using our free Kaleidoscope conversion software.

Triggered recording is available to further minimize card usage. Triggers do not work well for lower sample rates because there will likely be constant false triggers from ambient noise. For ultrasonic recording where there is much less noise sources triggers can be an excellent way to reduce data and only record when there is an event of interest. If triggers are set in WAV mode, the recorder will save a WAV file for each triggered event and will delete recordings that do not appear to contain biological activity. To discuss optimal settings for your particular deployment, please contact Wildlife Acoustics' support team at support2013@wildifeacoustics.com

For any single hydrophone configuration, the unit is shipped with both channels connected to the single hydrophone, so it is arbitrary which channel you select for recording. This does present some opportunity for creative recording. Different gain, sample rate and trigger levels could be used on the different channels. For example you might want to record at a high sample rate with a high pass filter to filter out lower sounds with more gain on one channel, and a lower sample rate with no filter and less gain on the other. Two sample rates cannot be used concurrently, but the recorder can easily be programmed to switch between two rates at different times.

Recording Schedule

The SM2M+ can handle any complexity of schedule. It is even possible to program different sample rates for different recording sessions. Details on scheduling can be found in the SM2+ User Manual. It is important to remember that when the SM2M+ is not recording it is in a very low power state such that low duty cycles can significantly extend the possible deployment longevity.

The SM2M will wake up 3.5 minutes before any scheduled recording period to give the hydrophone a chance to charge up for reduced noise

Main Batteries

The SM2M+ Submersible is powered with up to 32 D cells batteries and the Deep Water up to 64 batteries. The recorder can accept

1.5V alkaline batteries, 1.2V NiMH batteries or 3V-3.3V lithium batteries. The recommended lithium batteries are model U10026 from Ultralife Batteries. These are non-rechargeable lithium manganese batteries. Please contact Wildlife Acoustics support for more information.

A board containing protection diodes in two configurations must be configured for the appropriate cell voltage. As shipped the SM2M+ is configured for 1.5 or 1.2V cells. In this configuration the batteries are wired in parallel groups of 4 in series. To use 3V-3.3V cells the board must be removed, rotated 180 degrees and reinstalled. This configures the battery cells in parallel groups of 2. There is a small white arrow on the main battery board that aligns with the arrow on the diode board as shown in the 1.5V position below.

Warning: Installing D-cell batteries with a higher voltage than 1.5V without properly configuring the diode board shown below will damage the unit.
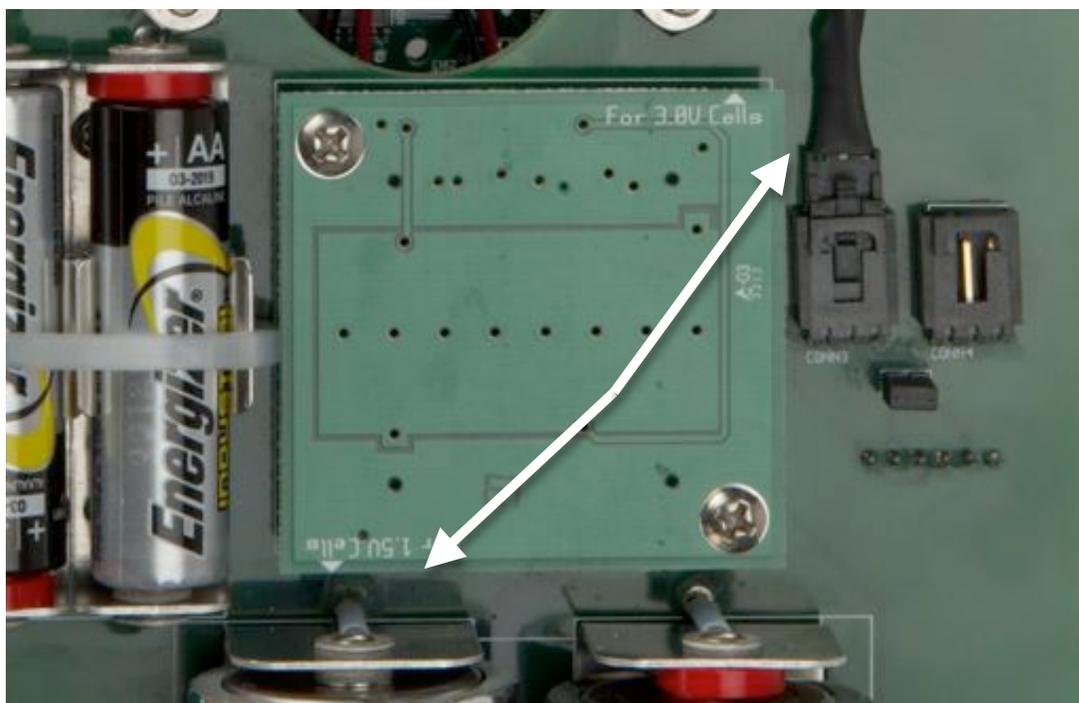
Batteries must be inserted in the proper groupings which are labeled "A" through "H" on the battery board. For 1.5V and 1.2V cells all four battery holders corresponding to a letter must be populated. Letters "F" and "C" have two on the back and two on the front. For 3V cells only two of each letter must be populated. If not filling all available battery positions, it is best to populate the letters closest to the bottom as that will help the SM2M+ float vertically.

The following chart shows approximate recording longevity in days for a 100% and 50% duty cycle schedule. Since the recorder uses very little power while sleeping, longevity for lower duty cycles can be deduced by multiplying the shown values (25% would be double 50% for example).

Number of Batteries	4kHz – 96kHz Sample Rate				192kHz/384kHz Sample Rate			
	Li-MnO2		Alkaline		Li-MnO2		Alkaline	
	100%	50%	100%	50%	100%	50%	100%	50%
4	13	26	7.8	16	6.3	10	3.7	5.9
16	53	105	31	62	22	41	13	24
32	105	211	62	124	42	81	25	48
64	211	422	124	248	84	163	49	96

This assumes 0 degree Celsius water and WAC0 compression. Battery life varies and this should be taken as a maximum figure.

With the ultrasonic option, the unit does use more power. However, it is important to note within each of the two categories in the chart (4 kHz - 96 kHz and 192 kHz/ 384 KHz) the rate selected will not greatly affect battery longevity. For example 96 kHz sample rate will not consume a significantly different amount of power compared to 4 kHz, nor will 384 KHz consume more than 192 kHz.

Clock Batteries

Two AA batteries run the SM2M+ clock. These should be alkaline batteries. While they can last up to two years, it is recommended to change them every year, if not for every deployment. There are two holes to either side of the battery holder and the batteries should be zip tied to the board using these holes.

Flash Cards

Up to four SDHC or SDXC cards can be installed in the recorder. SDHC cards are available up to 32GB and SDXC cards are currently available up to 128GB, with higher capacities coming. The following chart shows recording longevity in days for various total card capacities and sample rates using WAC 0 lossless compression. Using no compression (recording straight to WAV) will approximately halve these values. Lossy compressions are

available for even more compact storage. See the SM2+ Platform User Manual for more information.

Sample Rate (kHz)	32GB	64GB	128GB	256GB	512GB
384	0.8	1.6	3.2	6.4	13
192	1.6	3.2	6.4	13	26
96	3.2	6.4	13	26	51
48	6.4	13	26	51	103
16	19	39	77	154	309
4	77	154	309	617	1,235

Note: SDXC cards must be formatted to a FAT32 file system to work with the SM2M+. They will not work "out of the box". Please contact Wildlife Acoustics support for more information on how to reformat the cards.

Some flash cards cannot keep up with the high sample rates required for ultrasonic recording. This can result in occasional distorted areas in the recordings. The SM2M will suppress the effects of skipping flash cards making the effect less obvious so that the skips will not interfere with analysis. But for best results you should still check your flash cards with the SD card speed test in the Utilities Menu on the SM2M+. This test will test the SD card in slot A and takes 15-30 seconds to run. Results indicating 0/0 mean no problems were found. Otherwise, numbers indicate a first and possible second occurrence in seconds of a "glitch" where the flash card is unable to keep up resulting in losing up to one second of data. A 99 means the occurrence was greater than or equal to 99 seconds. Note that the test requires at least 64MB of free space on the card.

Sealing the Housing

The housing is sealed using two O-rings on the top cap. This is a redundant system, only one O-ring is necessary to seal, but two are used to assure a seal if one should become compromised. The O-ring seal is designed for depths far greater than the rated depth of the housing, so with proper installation the unit is sure to seal at any depth.

Preparing the Top Cap

It is extremely important that the O-rings be clean, free of defects and properly lubricated. Take the O-rings and apply a small amount of the included lubricant. Apply around the entire O-ring, feeling for defects with your fingers as you apply. Insert the O-rings on the cap as shown.

Next apply a thin layer of lubricant all the way around the smooth inner diameter of the housing where the O-rings will mate as shown in the area between the two arrows below. This area and the O-rings should be free of dust, hair and other debris.
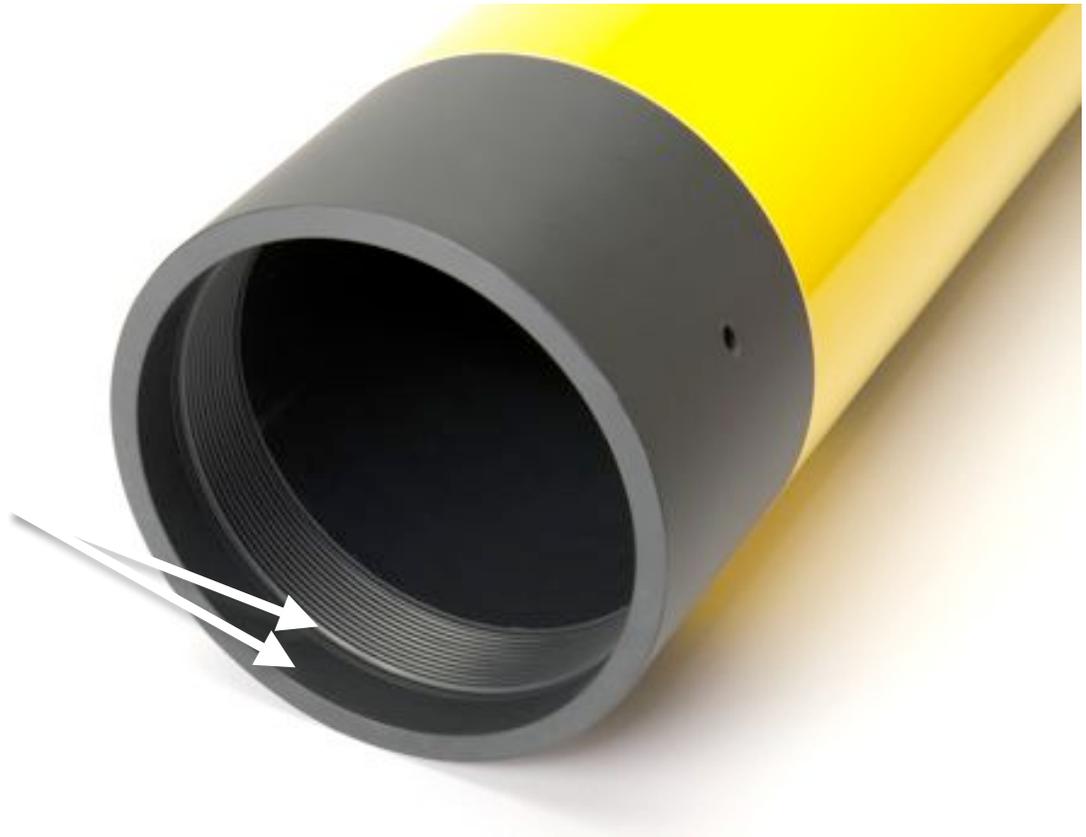
Installing Battery Board and Connecting

The battery board simply slides into the housing. The neoprene edging should be in place on the top and bottom of the board. When the top cap is tightened this holds the board in place and prevents movement during deployment. The hydrophone cable should be looped twice through the large finger hole at the top of the board and then plugged into either connector; they are both electrically tied together.

Looping the cable provides strain relief so the wire twists above the hole and not at the connection point. Always inspect the connector prior to sealing to make sure the wires are intact. Proper connection is shown in Figure 4 below (though again either connector can be used).

At this point it is prudent to run a final system test. An instant recording can be initiated by pressing the "up" and "down" buttons on the Song Meter board simultaneously and then stopped

by pressing the "back" button. Recorded sounds or vocalizations can then be immediately verified on a computer. Once satisfied, make sure the internal/external jumper is set to internal and the unit is powered. Press the "wake/exit" button and watch for with an announcement of scheduled recording time if in the future or "preparing to record" if the schedule starts with record. The LED light on the Song Meter board will also blink once a second during a recording and once per minute when awaiting a scheduled recording.

Drop a desiccant pack into the bottom of the housing before installing top cap. Remaining desiccant should be kept in zip-lock bags to prevent them from absorbing moisture.

Installing Top Cap

Before inserting the cap, rotate the cap in the reverse direction of tightening four times. It takes eight turns to seal the cap, so this will keep a maximum of four turns on the hydrophone cable.

Insert the cap and rotate by hand a couple turns to get it started. When the first O-ring engages it will become more difficult. Insert the included spanner wrenches into the interfacing holes. One wrench interfaces with the two holes in the housing and the other interfaces with the 4 holes in the top cap. It is easiest to do the procedure while sitting atop the pipe (as though riding it). You can hold the housing wrench stationary and rotate the top cap, moving to a new hole as it is tightened. The wrenches are identical. Apply force as shown below to tighten.

After six more turns it will get more difficult as the second O-ring engages. Continue tightening until there is no gap between the top cap and the cylinder as shown in below.

Now insert each of the four legs of the hydrophone cage into the four top cap holes.
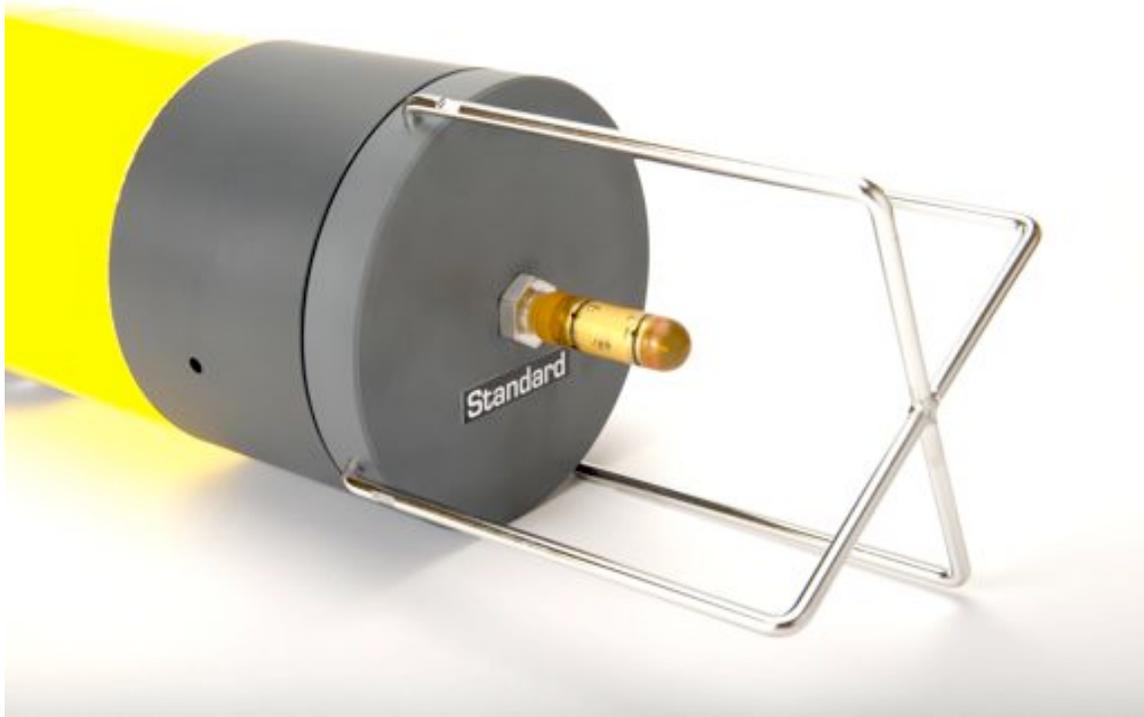
Cinch a cable tie around the entire assembly to prevent the cage from slipping out of the mounting holes. There are grooves in the side of each leg to hold the cable tie in place.

The unit is now ready to be attached to an anchor system and deployed.

Note: The SM2M+ package includes 4 O-rings, 5 packs of desiccant and a tube of O-ring lubricant. Additional deployment supplies can be purchased from McMaster Carr (http://www.mcmaster.com/). O-rings are part number 9557K333for the Submersible model or 9557K335 for the Deep Water model. 5 pack of desiccant is part number 2189K18. O-ring lubricant is part number 9463K33 .

Deployment

Depth Rating

The SM2M+ Submersible's PVC housing is conservatively rated to 500ft (150m). This figure assumes a ten-year deployment life. In pressure testing, failure did not start until the equivalent pressure of about 1000ft (300m). Deployments deeper than 150m are possible but not covered under warranty and will decrease the housing's effective deployment lifespan.

The SM2M+ Deep Water's anodized aluminum housing is conservatively rated to 5000ft (1500m). In pressure testing, failure did not start until the equivalent pressure of about 1000ft (3000m), but for long term deployments we can only guarantee with warranty deployments under the 1500m rating.

Anchoring Solutions

The SM2M+ can be anchored from the 316 stainless steel eyebolt on the bottom of the housing. For the Deep Water there is a mounting bracket welded on to the bottom.

The eyebolt was tested for a 150lb load. Certainly a larger anchor could be used, but it is recommended that no more than 150lb be placed on the eyebolt in air.

The unit(s) can be tethered directly to an anchor for diver release, or tethered to a surface structure. Acoustic releases are commercially available which allow the unit to be released from the

ocean floor by playing an acoustic signal from the surface. In this case, it is generally necessary to use a subsea float to increase the visibility of the housing when it surfaces.

Retrieval and Shipside Refurbishment

Retrieval

Regardless of method of retrieval, take care in getting the unit shipside not to damage the hydrophone. If planning on using hooks to snare the housing, it might be best to deploy with a ring of floating nylon line attached to the bottom eyebolt to give a hooking point. It would also be possible to attach rigging to the unit use large stainless steel band clamps around the diameter of the housing.

Opening Recorder

After a long deployment in shallow water, the unit is likely to have accumulated significant biofouling. It may be necessary to clean the top of the cylinder to access the holes for the spanner wrenches.

On the SM2M+ Submersible, the hydrophone cage must be removed to allow the spanner wrench to interface with the top cap side holes. Remove the cable tie around the hydrophone cage and pull the four cage legs from the top cap holes to fully remove the cage. This is not necessary, nor is it possible to remove the cage on the Deep Water unit.

To get the top cap started, give a good impulse of force to the spanner wrench, and then proceed opposite sealing as shown in Figure 9.

Flash Card and Battery Replacement

To remove the board, first disconnect and remove the hydrophone cable and then simply pull the board from the housing using the large finger hole at the top of the board. The D cell batteries can

simply be removed and replaced. Also replacing the AA batteries to assure that the clock setting is maintained is recommended.

Flash cards can either be swapped for new empty cards or, if time allows, inserted into a laptop, transferred and then erased.

Resealing

The O-rings should be removed and the top cap thoroughly cleaned, paying special attention to the O-ring area. The inner diameter of the housing should also be well cleaned, again particularly where the O-rings will contact the housing. The O-rings themselves should be cleaned and then inspected for any damage, it is best to be on the safe side and replace them when in question. The desiccant pack is not reusable and should be replaced for every deployment. Give the entire housing an inspection to make sure there is no damage to the housing, the attachment points or the hydrophone. Check to make sure the hydrophone is still tight to the top cap, the metal of the hydrophone connector should make contact with the surface of the top cap. Next the O-rings should be lubricated and the unit sealed as per previous instructions.

Storage and Transport

The SM2M+ ships in a high quality case suitable for storage and shipment. The case has wheels on one end for ease of travel and two latches which can accept locks for security. An accessory compartment allows storage of the spanner wrenches, O-rings, lubricant desiccant and other needed supplies.

The SM2M+ should have the hydrophone cage installed when transported in the case as shown in Figure 10. This assures a tight fit and protection from impact.

Specifications

Physical Specifications

SM2M+ Submersible

Height:	31.25 in (79.4 cm)
	Including eyebolt and hydrophone.
Diameter:	6.5 in (16.5 cm)
Eyebolt Anchor:	1.7 in (4.3 cm) outer diameter
	1.0 in (2.5 cm) inner diameter
	2.0 in (5.1 cm) height off housing
Standard Hydrophone:	2.50 in (6.4 cm) length
	0.75 in (1.9 cm) diameter
Weight (air):	21.0 lb (9.5 kg) with no batteries
	31.0 lb (13.5 kg) fully populated with batteries
Buoyancy (salt water):	12.0 lb (5.5kg) with no batteries
	3.0 lb (1.5 kg) fully populated with batteries
Rated Depth:	500ft (150 m)

SM2M+ Deep Water

Height:	58.3 in (148 cm)
	Including bottom mounting bracket and hydrophone cage
Diameter:	6.5 in (16.5 cm)
Mounting Bracket Slots:	1.5 in (3.8 cm) high
	3.0 in (7.6 cm) wide
Standard Hydrophone:	2.50 in (6.4 cm) length
	0.75 in (1.9 cm) diameter
Weight (air):	53.8 lb (24.4 kg) with no batteries
	71 lb (32.2 kg) fully populated with batteries
Buoyancy (salt water):	2.2 lb (1 kg) with no batteries
	-21.6 lb (-9.8 kg) fully populated with batteries
Rated Depth:	5000ft (1500 m)

Electrical Specifications

Audio Sample Rate:	4 kHz – 96 kHz (4 kHz – 384 kHz with Ultrasonic Upgrade)
Storage Media:	Up to four 32GB SDHC or up to four 128GB SDCX
Submersible Battery Capacity:	Up to 32 alkaline, LSD NiMH or lithium manganese cells
Deep Water Battery Capacity:	Up to 64 alkaline, LSD NiMH or lithium manganese cells

Note: Full specifications for the SM2+ Platform can be found in the SM2+ Platform User Manual.

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