

microMARS™ Manual

Version 1.06



This manual has been authored by Alfonso Gutierrez.

If you have any criticism, suggestions, or praise, are enlightened, or are confused, I would like to hear from you! Please send me an e-mail at a.gutierrez@desertstar.com.

**THIS SD CARD TYPE
ONLY
EXTREME PRO SDHC/SDXC UHS-I**



Failure to
use this
card type
WILL result
in mission
failure.

Approved Sizes:
32GB - 512 GB

microMARS: Origin and Advantages

Origin

Thank you for your interest in or for purchasing the micro Marine Acoustic Recorder System (microMARS). The origin of this recorder is with [NOAA's Advanced Sampling Technologies Working Group \(ASTWG\)](#) and NOAA researcher Brad Hanson. Brad's group had long been using underwater acoustic recorders to monitor the migration of whales and dolphins along the northwest coast of the United States. However, the generally large size of available recorders for long-term monitoring and associated deployment logistics (bigger mooring package, requirement for larger vessels) and higher cost meant that these recorder arrays were sparse, with few recorders.

Having already designed the various base technologies needed for a miniature underwater recorder under previous NOAA sponsored [SBIR](#) work, Desert Star Systems and partner [Biowaves](#) submitted a proposal for a low cost recorder roughly the size of a can of soda that would be optimized for deployment in large numbers.

By the early summer of 2014, first fully functional prototypes were finally available and we started a series of field tests in Monterey Bay, along California's central coast, at Catalina Island and even the Baltic Sea. The objective was to test microMARS under a variety of conditions, check the recording quality, and record first animal vocalizations. The test series then concluded with a week at Friday Harbor Lab (near Seattle, WA). Working with Ken Balcomb, a pioneer in whale research as well as underwater acoustics, we had the opportunity to both exercise microMARS in various deployment configurations (static sea floor with acoustic release, hanging from dock, ocean drifter) and record the vocalization of pods of Killer Whales. The sum of these tests is described in a field test report and is worthwhile reading as a companion to this manual.

Since then, microMARS has been successfully used in a larger scale (ten recorders) deployment to monitor industrial noise for marine mammal protection, and for several other jobs that are in progress. In the process, it has proven extremely easy to deploy, reliable in its operation and, due to its modular design, adaptive to a variety of job requirements. For example, the industrial noise-monitoring job required capturing and measuring very loud low frequency noise with spikes in excess of 200 dB. Yet, thanks to a hydrophone end-cap programmed with a sloped frequency response curve (less sensitive at low frequencies, more sensitive at high frequencies), the recorders also captured faint biological noises in higher parts of the spectrum.



Rigging a string of recorders



Deployment as ocean drifter

microMARS Advantages

Small size simplifies deployment: microMARS' small size (roughly the size of a soda can) translates to a small deployment package. An 8lb hard float, a 1/8inch mooring line and a 15-20lb anchor weight suffices for many applications. This means that microMARS can be effectively deployed just about anywhere and from the smallest of vessels including workboats, RIB inflatables, and even kayaks.

Endurance: microMARS is well suited for long deployments due to minimal power consumption and a large memory capacity. Even at the top sampling rate of 250 kHz, the small single battery version provides about two weeks of continuous recording. Moreover, when upgrading to the quad battery version (which is about 20 cm longer), two months of continuous operation is available. Duty cycling and acoustic event detector modes further lengthen endurance, allowing realistic yearlong deployments and more.

Flexible and affordable memory: microMARS relies on SD card memory, offering two or eight slots. As memory cards grow in capacity and drop in price, microMARS becomes more powerful. At the time of this writing, 512GB SD cards have been announced, setting microMARS capacity at 4TB. That is more than enough to support the quad battery recorder's eight-week battery endurance at 250 kHz sampling rate (2.4 TB needed).

Easy recovery: The recorder's small size also makes it compatible with our ARC-1 acoustic release, which due to its high reliability (its patented mechanism has a single moving part), fast response, acoustic ranging, small size and moderate cost has long been popular for the installation of large instrument arrays and recovery of lobster pods. Connect the ARC-1 between the anchor weight and the recorder. Range to it and trigger it from the deck box to recover your equipment within a matter of 1-2 minutes.



microMARS rigged with ARC-1 acoustic release. Deck box and over-the-side transducer on right.



Deploying a microMARS with ARC-1 acoustic release

Rapid servicing: When it comes to servicing large recorder arrays, efficiency, and effective use of ship time, is of key importance. microMARS complies. Once on deck, it is quickly opened up and SD cards and battery are replaced. Within minutes, the recorder is ready for deployment at the next mooring station, in assembly line fashion. In addition, once you have your stack of cards in the lab, the microMARS Reader software batch converts to WAV files, accepting all eight cards of a recorder via a USB hub and set of card readers supplied with the starter kit.

Replaceable hydrophone end-caps: microMARS can be configured to measure intense pile driving noise with peaks well over 200 dB at the monitoring station, and faint distant marine mammal vocalizations in quiet environments. This is made possible by microMARS' replaceable hydrophone end-caps. Integrating the hydrophone element and a pre-amplifier, the tough end-caps generally cost around \$500 and optimize your recorder for any job. Use a high gain end-cap for weak signals, or low gain for strong signals. Alternatively, use an end-cap with a sloped frequency response, capturing intense low-frequency industrial noise at the same time as monitoring faint vocalizations from marine mammals at higher frequencies.

Low Cost: microMARS is favorably priced compared to other recorders. We minimized costs, in order to facilitate the recorder's use in large numbers under a reasonable budget. Use it to obtain a denser data set than would otherwise be possible.

Modularity: A modular design allows microMARS to grow in capabilities, preserving your investment. Over time, we will broaden the range of hydrophone end-caps, extend the ADC resolution beyond 16-bit, provide time synchronization for sound source localization, offer greater depth ratings and more. Firmware updates will be available on-line, extending the capabilities of the recorder. Other upgrades will be by replacing components, such as greater depth rating (thick wall housing tube) or addition of a precision GPS-synchronized timing module.



microMARS components

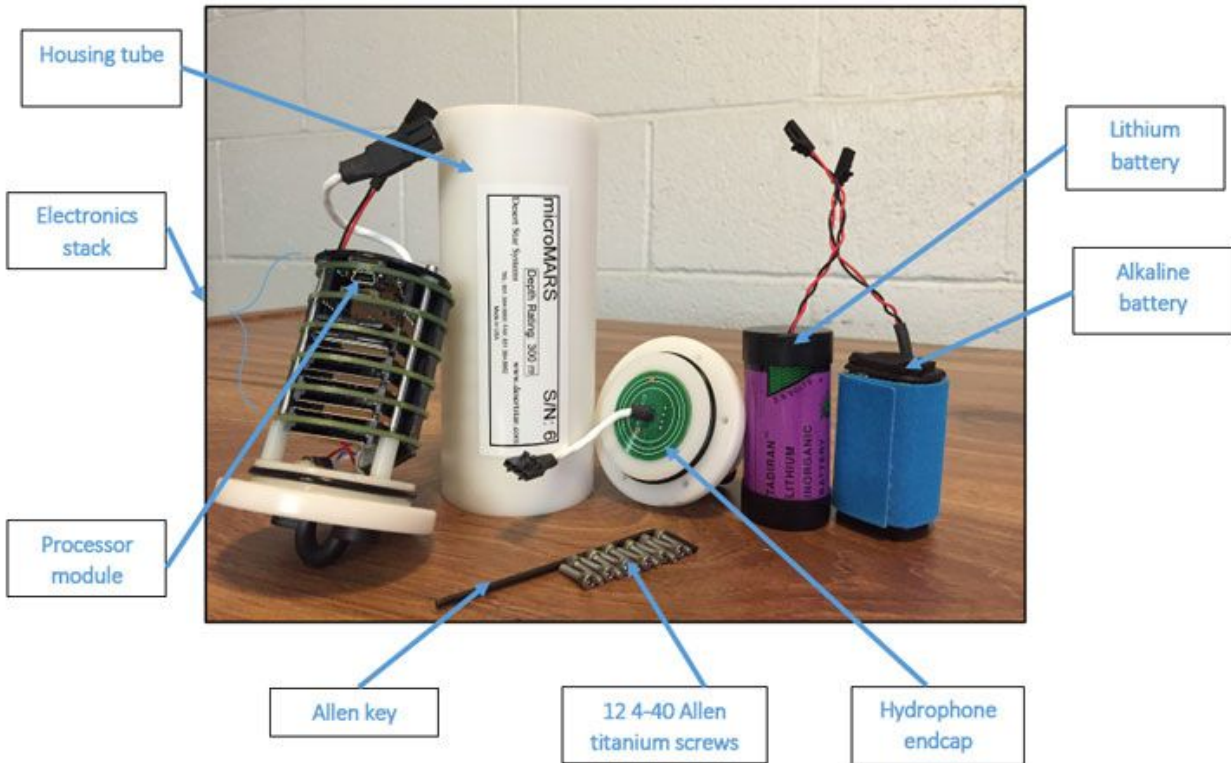


Data retrieval via SD card readers

microMARS Overview

Components

The components of the microMARS device include a battery (Lithium and Alkaline), a Hydrophone end-cap, a housing tube, an Allen key, the 12 4-40 Allen titanium screws, and an electronic stack—with SD cards (that range from 2-8 cards), their ports, and the mini USB port.



Recorder Disassembly & Assembly for Configuration & SD Card Access

Disassembly

- Clean and dry microMARS well before opening to avoid introducing moisture or debris so as not to cause damage to the electronics stack.
- First, remove the six 4-40 titanium screws with the supplied Allen wrench from the Hydrophone end-cap. Note: Care must be taken not to over-tighten the end-cap screws to prevent thread stripping. Tighten screws to a snug position and not more. If threads become stripped, replace the recorder housing tube.
- Using your thumbs gently press up on the lip of the device until a small gap is exposed between the end-cap and tube (Figure 1). Use a paper towel to wipe any moisture from the gap that may have accumulated between the endcap and tube before fully unseating the O-ring (Figure 2) After thorough drying, continue gently to use your thumbs to press upward carefully to remove the hydrophone endcap.

Figure 1

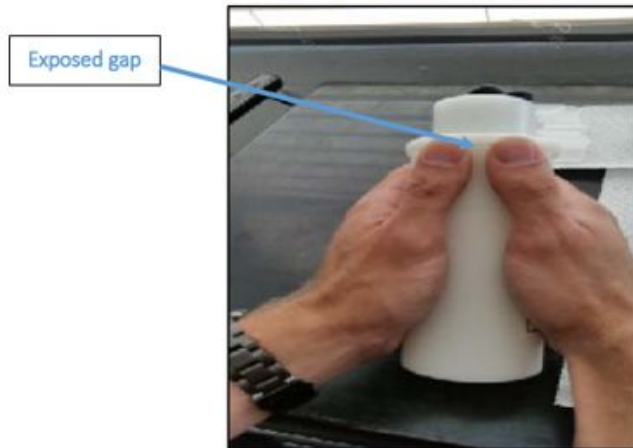


Figure 2



- Disconnect the Hydrophone and battery connectors by pressing the release tab and pulling gently (Figure 3).

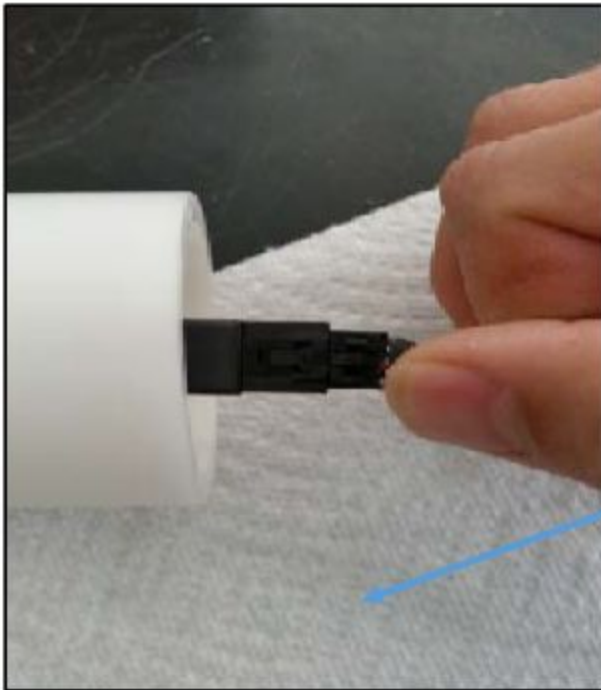


Figure 3

Release tab

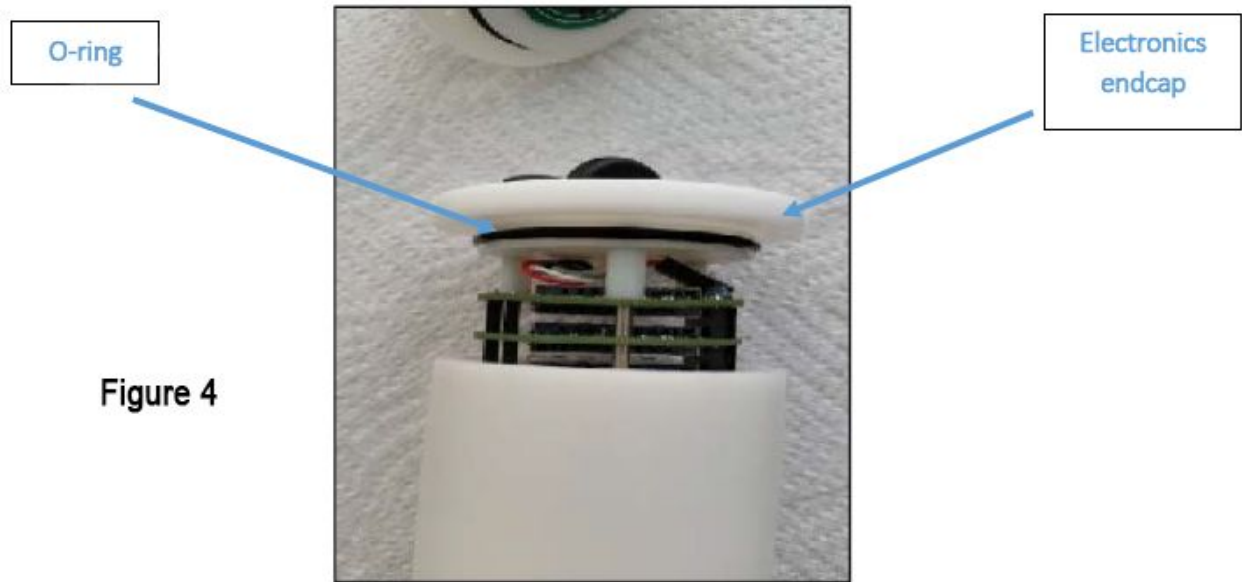


Daisy-Chained [Tardiran Batteries TL-5830/F](#)

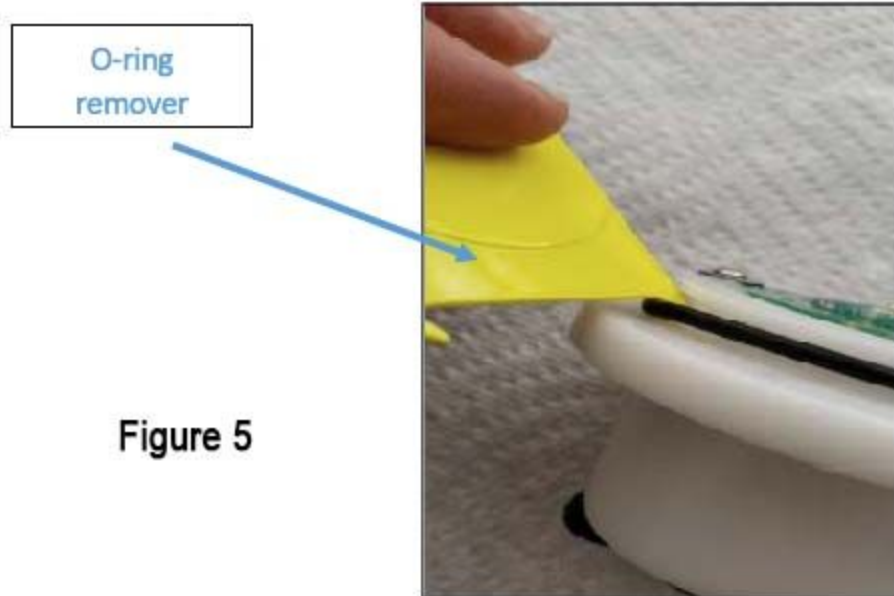


- Remove the six 4-40 titanium screws with the supplied Allen wrench from the other end-cap.
- Remove the electronics end-cap using the same method as for the hydrophone end-cap (e.g., with your thumbs gently pressing up on the lip of the device). The electronics stack

is bolted to this end-cap. Take care not to rub the stack against the inside of the tube as doing so can damage the O-ring surface of the tube (Figure 4).



Maintenance



Remove O-rings from end-caps using supplied plastic O-ring removal tool (Figure 5). Do not use metal tools as this may damage the O-ring seating surfaces or cut the O-ring.

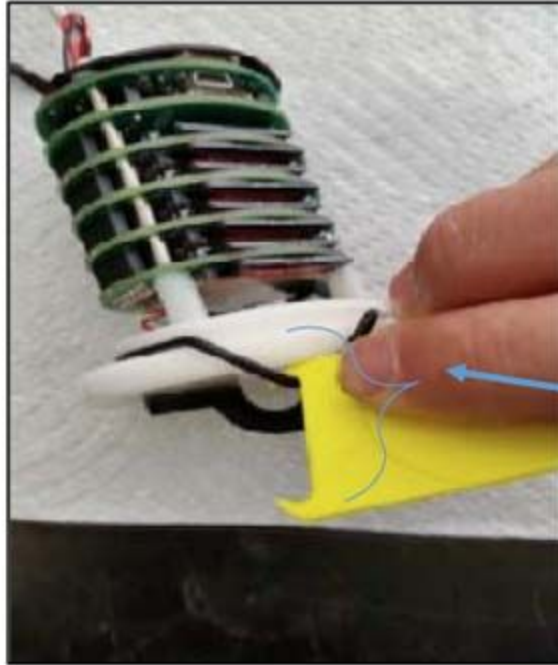


Figure 6

Electronics
stack

When removing the O-ring, stretch O-ring over the end-cap using supplied plastic O-ring removal tool rather than over the stack as the sharp edges of the circuit boards can damage the O-ring (Figure 6).

- Using a clean paper towel, clean all surfaces including the O-rings of excess grease and debris.
- Inspect all O-rings and O-ring surfaces. If O-ring surface of the housings are damaged replace immediately. See parts list.
- Inspect circuit stack for signs of moisture and/or damage. Do not disassemble the stack. Do not remove the stack from the endcap. If any of the titanium screw are lost or damaged, replace using only the supplied spare titanium screws. Do not replace with stainless steel screws, as stainless steel screws may fail quite quickly due to crevice corrosion in the seawater environment.
- Inspect the black attachment loops at ends of device for damage and replace if necessary.
- Reapply supplied silicone grease; use only a thin film on all O-rings and O-ring surfaces. There should be no build up and no gobs.

Reassembly

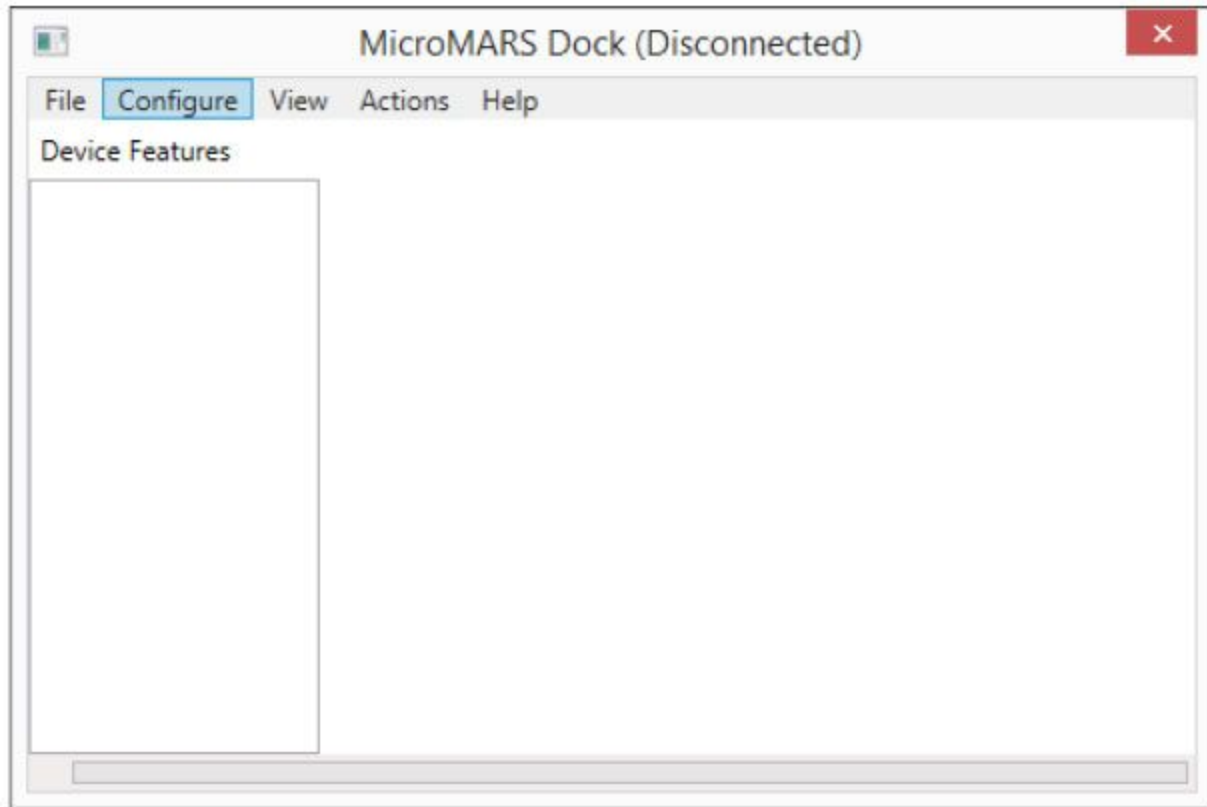
- Install O-rings in the same manner that they were removed.
- Install all SD cards into the memory card receptacles in the circuit stack by pressing in until they click.
- Insert the electronics endcap assembly into the housing tube, pressing evenly to seat the O-ring. It will have a distinct “popping” feel.

- Rotate endcap to align all screw holes with the ones in the tube.
- Insert and tighten the supplied 4-40 titanium screws. Take care not to over tighten, as it only is required to be snug. Tightening the screw more has no effect on sealing the O-rings and may strip the threads in the housing tube.
- Connect and insert the battery with its wire attachment down the device first. Align battery cable and connector in a clean service loop at the side of the battery.
- Connect the Hydrophone endcap connector and slide it in the space besides the battery.
- Install and tighten the Hydrophone endcap in the same manner as the electronics endcap, aligning screw holes before seating the endcap. Make sure not to twist the Hydrophone endcap more than a minor adjustment to avoid stressing the Hydrophone cable.

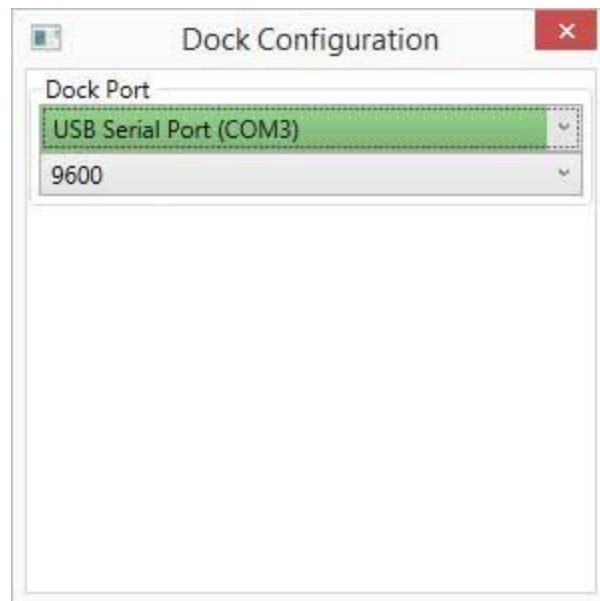
Recorder Configuration

To configuring the microMARS device, take out of cylindrical housing tube. Chapter II states how a user is to disassemble carefully their device to get to the electrical stack. Get appropriate USB wire, plug larger end of the cable into a port in provided laptop and the other end into electronic stack of mini USB port, located just under the Processor Module. Once connected, follow instructions below.

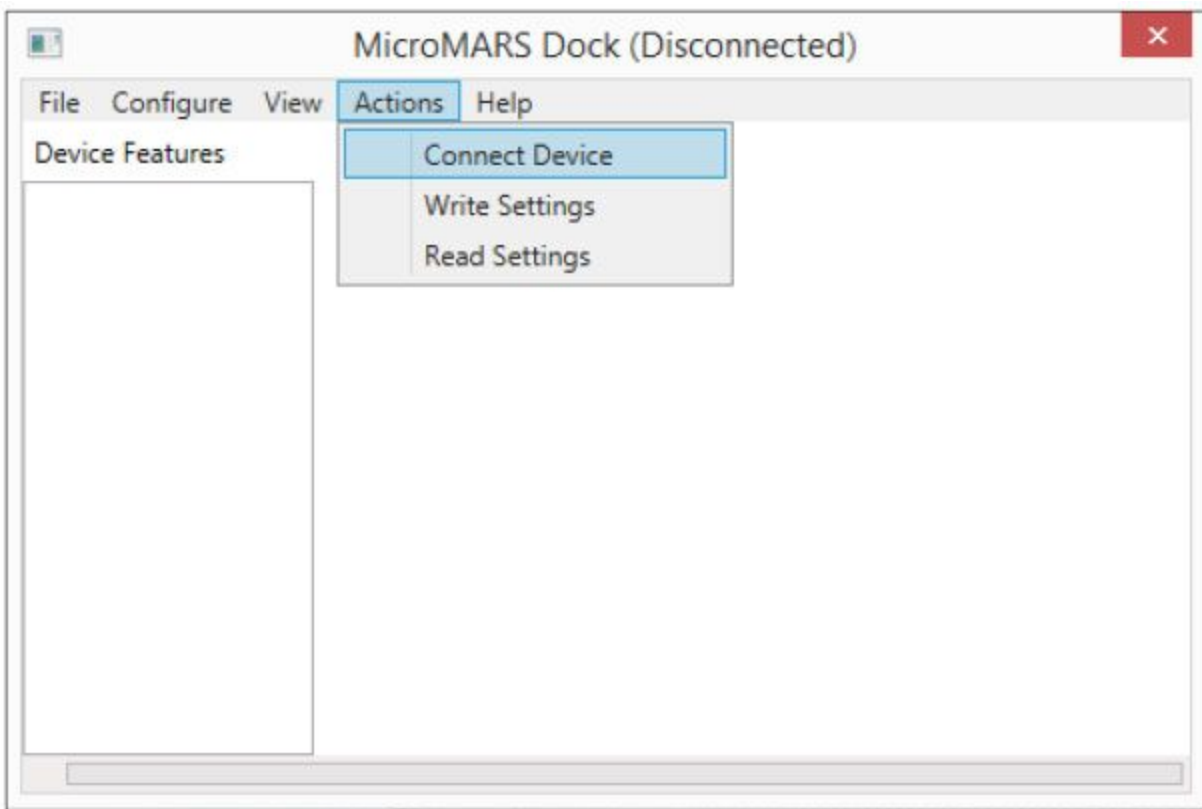
- The following set of screenshots were captured to show the process of configuring, or arranging the microMARS device for desired settings.
- Once the microMARS device has been properly connected start the microMARS Dock software.



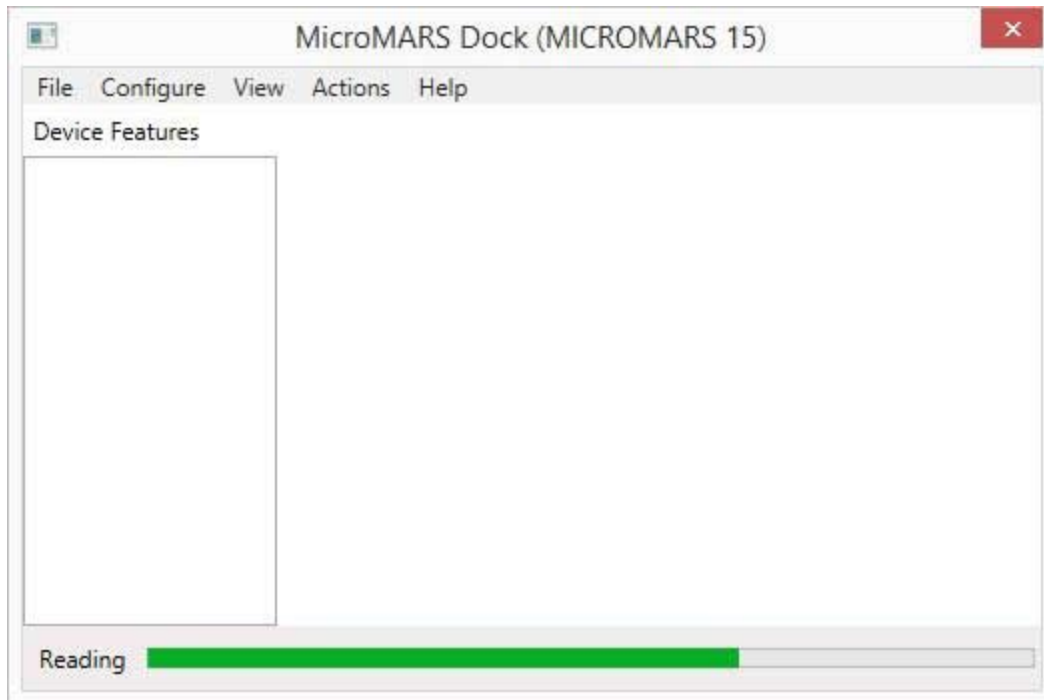
- Configure microMARS device. Screenshots below instruct how to further configure microMARS device.



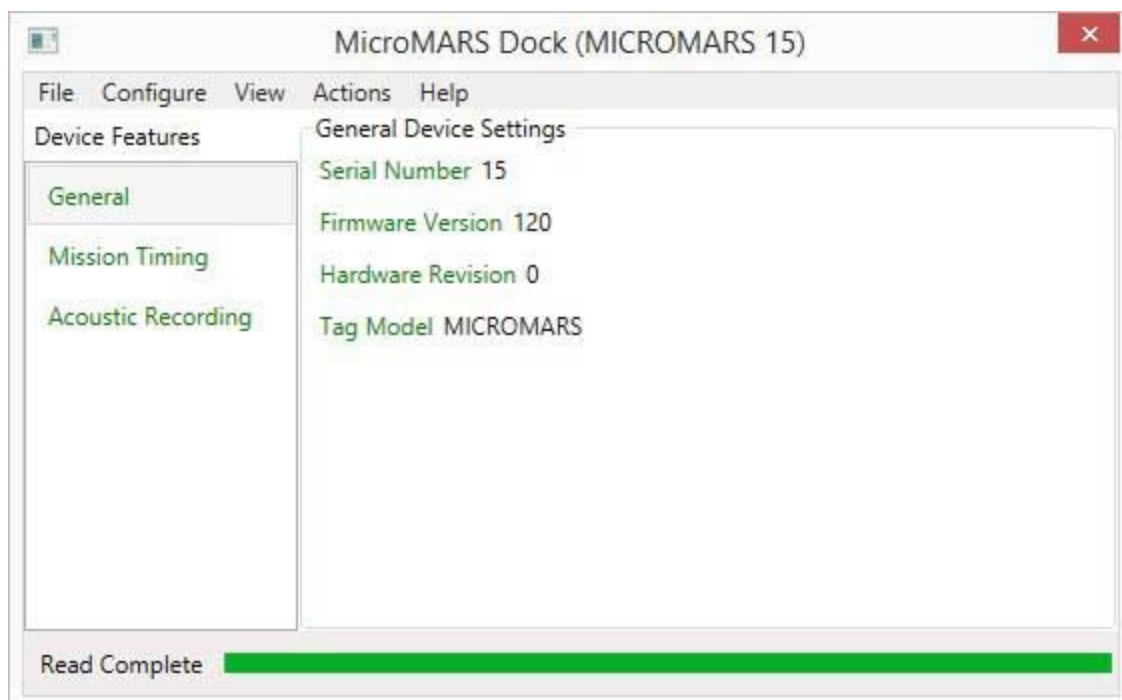
- Configure microMARS device by selecting correct COM Port, appearing in green. Note: Do not change “USB Serial Port” number. Leave as 9600.



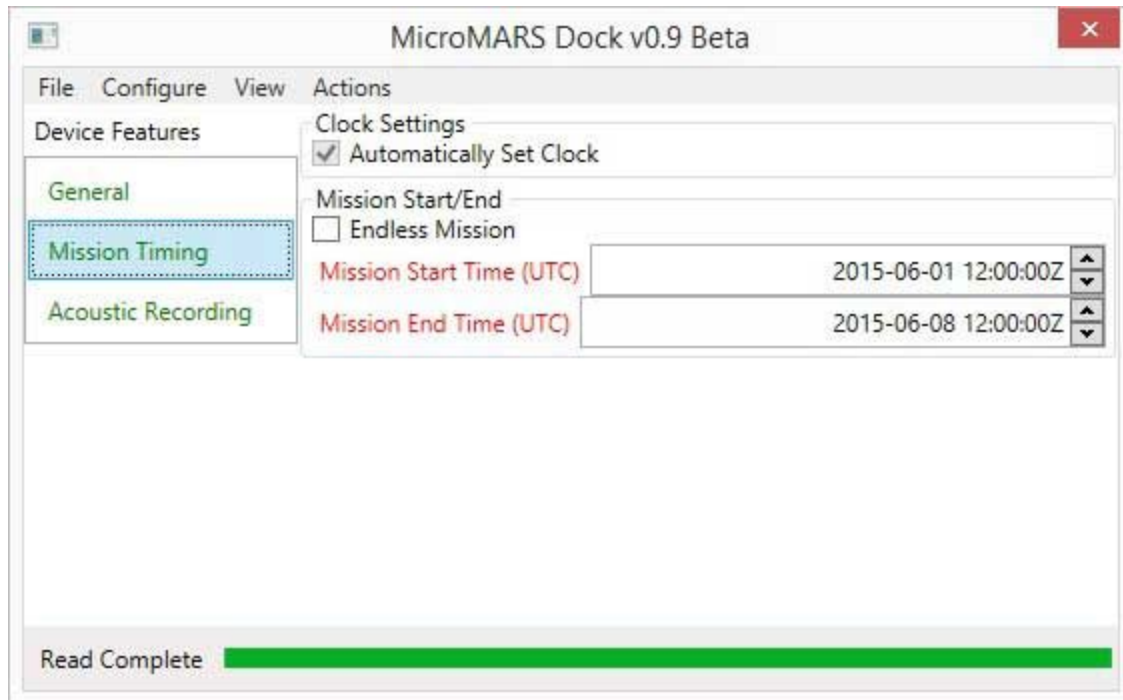
- Connect microMARS device by selecting “Actions” then “Connect Device,” as above.



- Device is still connecting, shown above as the green "Reading" bar.

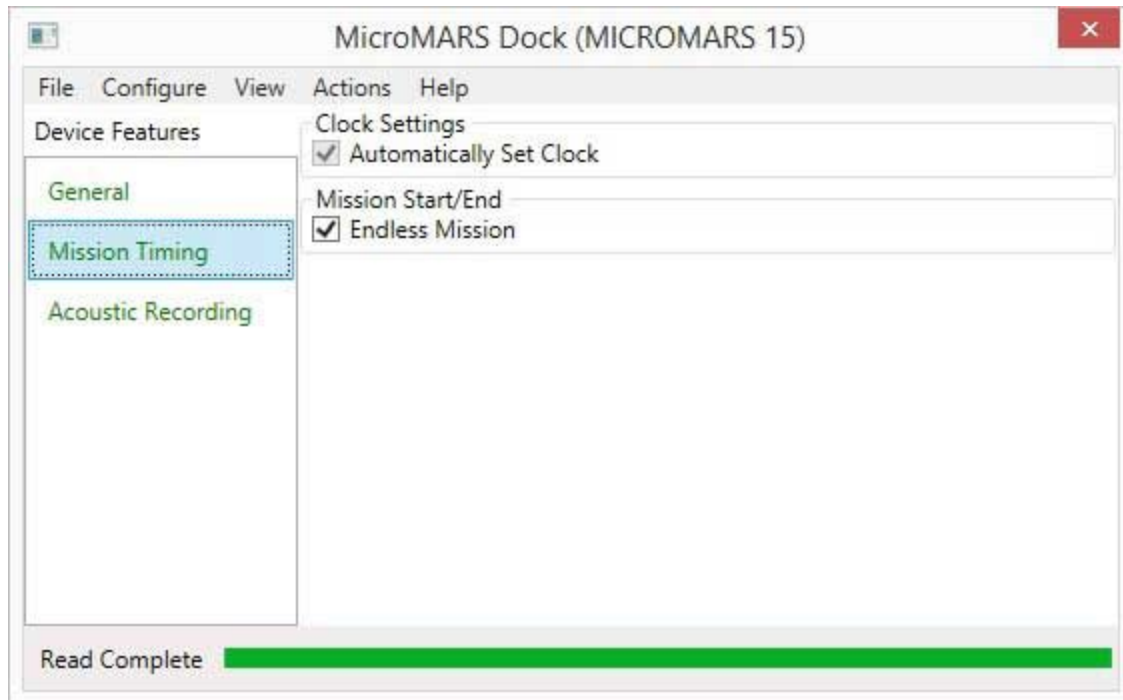


- Device has connected, shown above as "Read Complete."



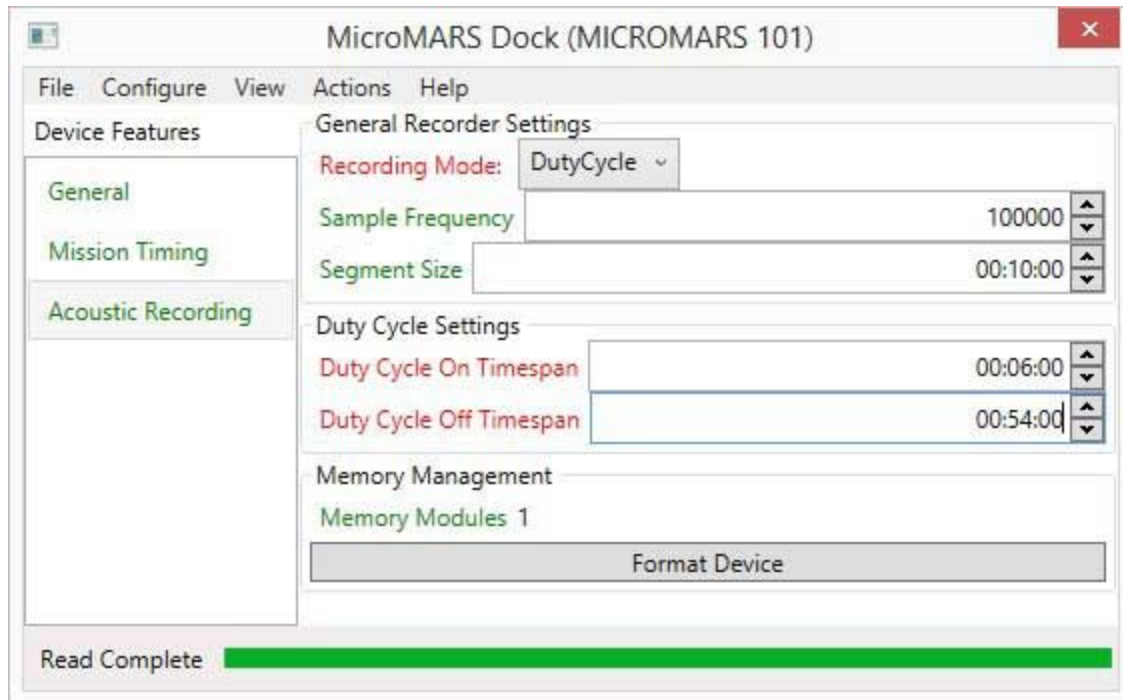
- Recording start and end date and time can be set here. Can be used to configure the recorder some time in advance and conserve battery and memory for when the recorder is actually deployed. A week of recording is shown above.

Endless Mission



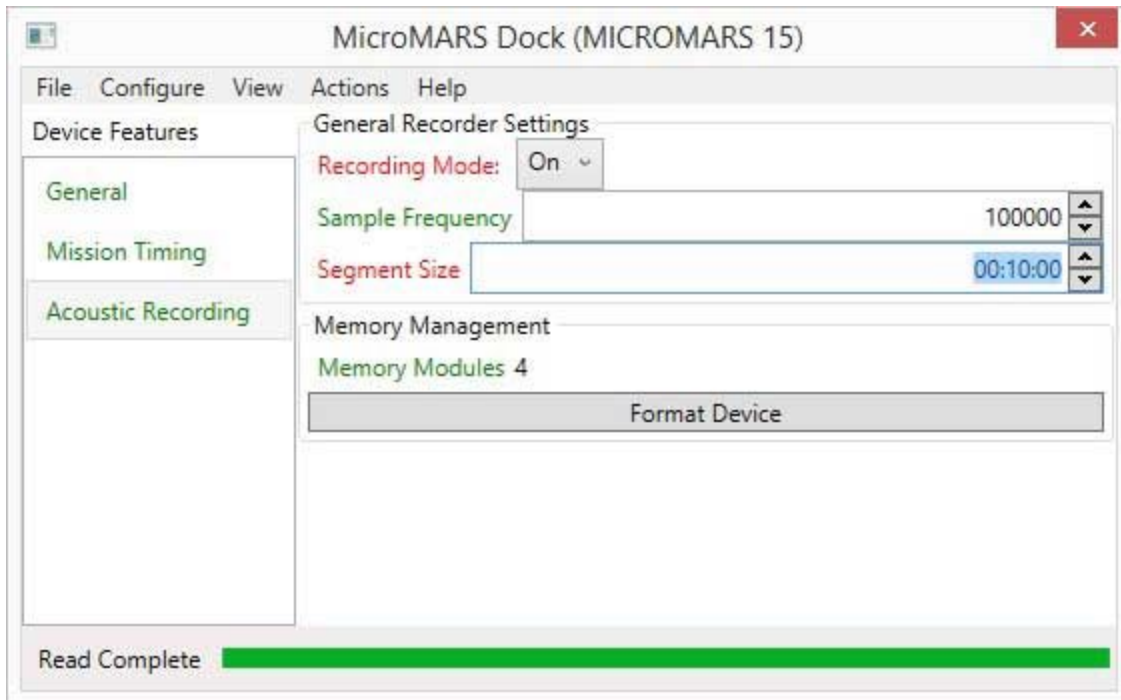
- “Endless Mission” is an alternative option. The recorder will start immediately and run until the battery is depleted. Lithium-ion battery recording endurance is approximately 17-18 days. Alkaline continuous runtime is approximately 2.5 days. Quad-battery recorder version offers four times this endurance.
- microMARS has three recording modes: ON, DutyCycle, and Acoustic Event. More detail below.

DutyCycle Recording Mode



- “DutyCycle” is used to extend battery life. The example above of 6 minutes ON and 54 minutes OFF is equivalent to a Duty Cycle of 10%. So, the battery life is 10 times longer than for continuous recording.

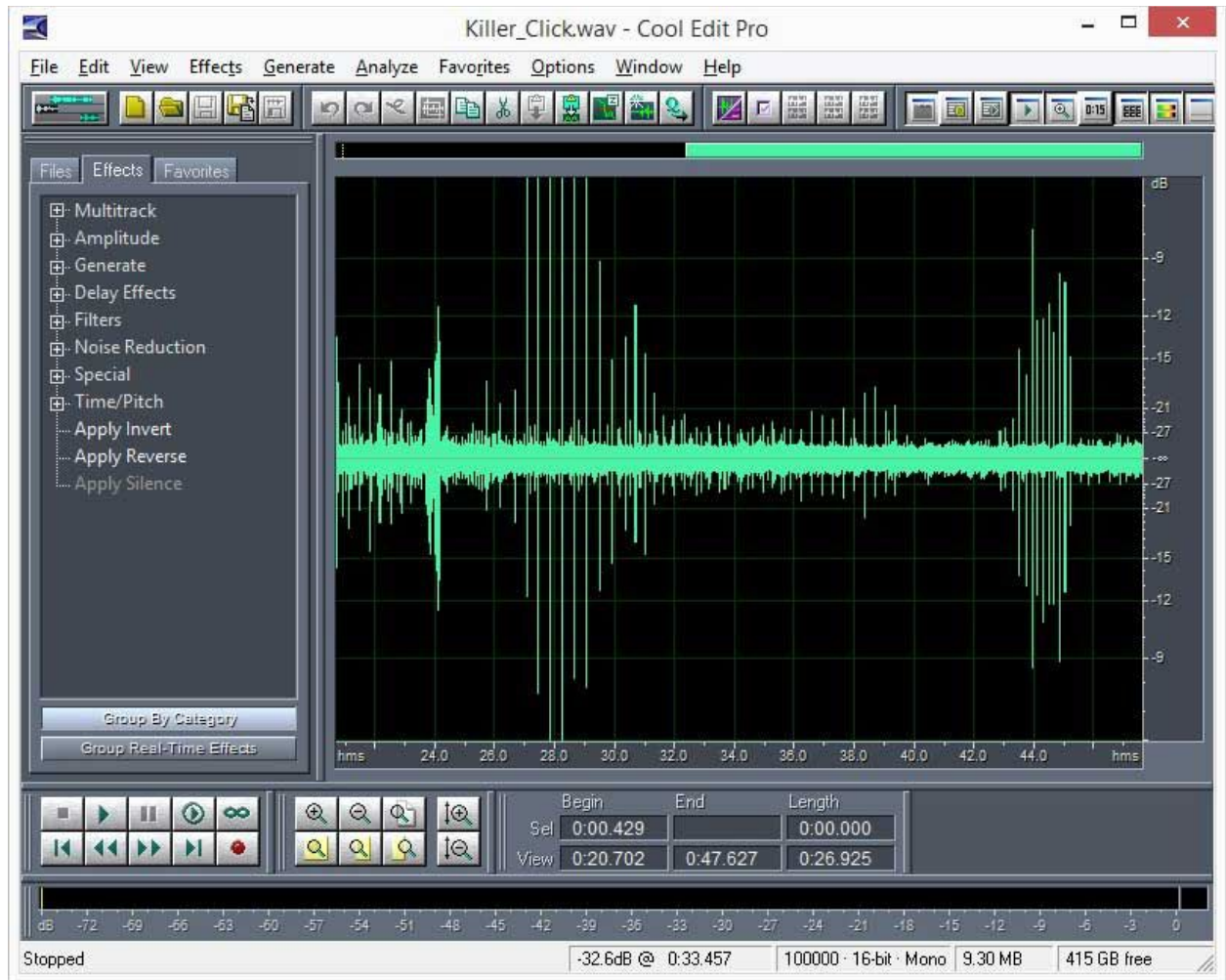
ON Recording Mode

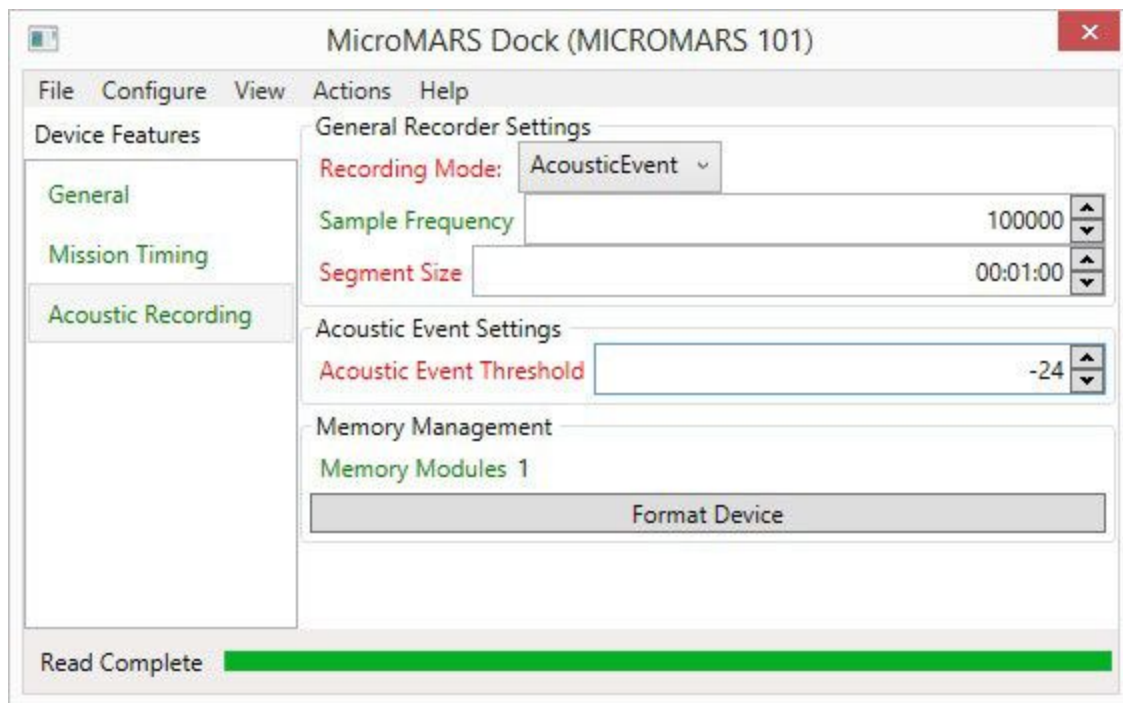


- Recording mode set to “On” will permanently record until batteries are depleted, memory is full, or the specified and recording time is reached.
- “Acoustic Recording” sets the “Sample Frequency” (Hz) and “Segment Size.” The segment size defines the length of each recording segment and limits the file size. For example, the above selection of 100,000 Hz sample frequency and 10 minute segment size (shown in blue above) will result in a file size of: $100,000 \text{ (samples / sec)} * 600 \text{ (sec)} * 2 \text{ (bytes / sample)} = 120 \text{ Mbytes}$.

AcousticEvent Detection Recording Mode

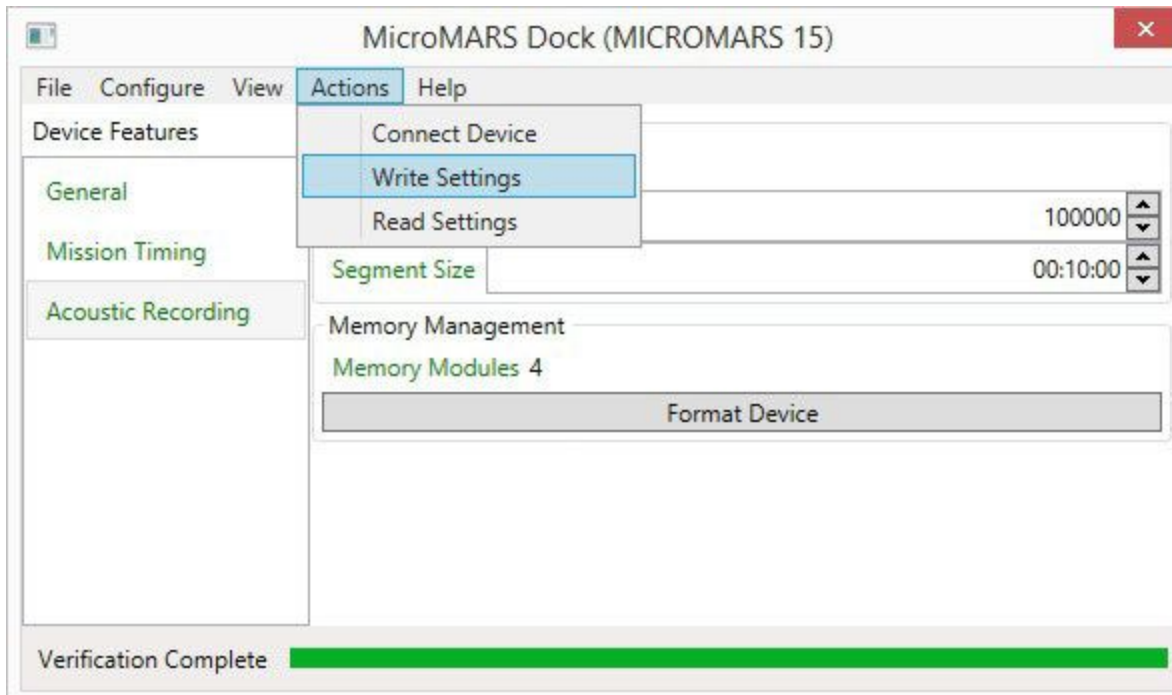
An acoustic event records when a signal above a define threshold has been detected.



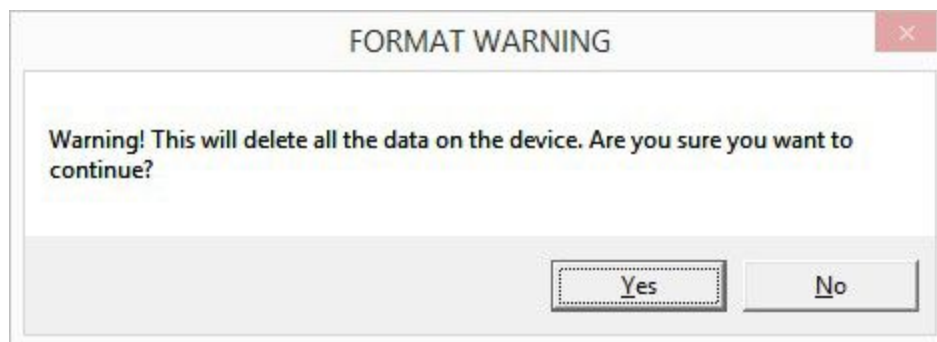


“Acoustic Event” Recording Mode records only when a signal exceeds the set Acoustic Event Threshold (dB) recording then continuous for the duration of the specified segment size. The above waveform are clicks of killer whales. The background noise in this example is approximately -30 dB; the spikes are the Killer Whale clicks. Setting the Acoustic Event Threshold to -24 dB, the recorder will not be triggered by ambient noise but will start recording when Killer Whales are present. Like Duty Cycle Mode, battery and memory endurance can be greatly extended; however, in contrast to Duty Cycle Mode, recording activity is targeted to capture signals of interest. Acoustic Even Detector Mode is not frequency specific and requires that the signal of interest is dominant. This works well for Cetacean clicks and buzzes, but may be problematic for Cetacean whistles that have a lower intensity and may not rise significantly above the total ambient noise amplitude. Note that Acoustic Event Detector Mode consumes about 10% of recording power while listening but not recording. Therefore, the battery will deplete in about 170-180 days for a single lithium battery, even if no signals are detected. See also Technical Specifications.

Write Settings



- “Write Settings” after user has set sample frequency and segment size, which calibrates the microMARS to desired user settings.



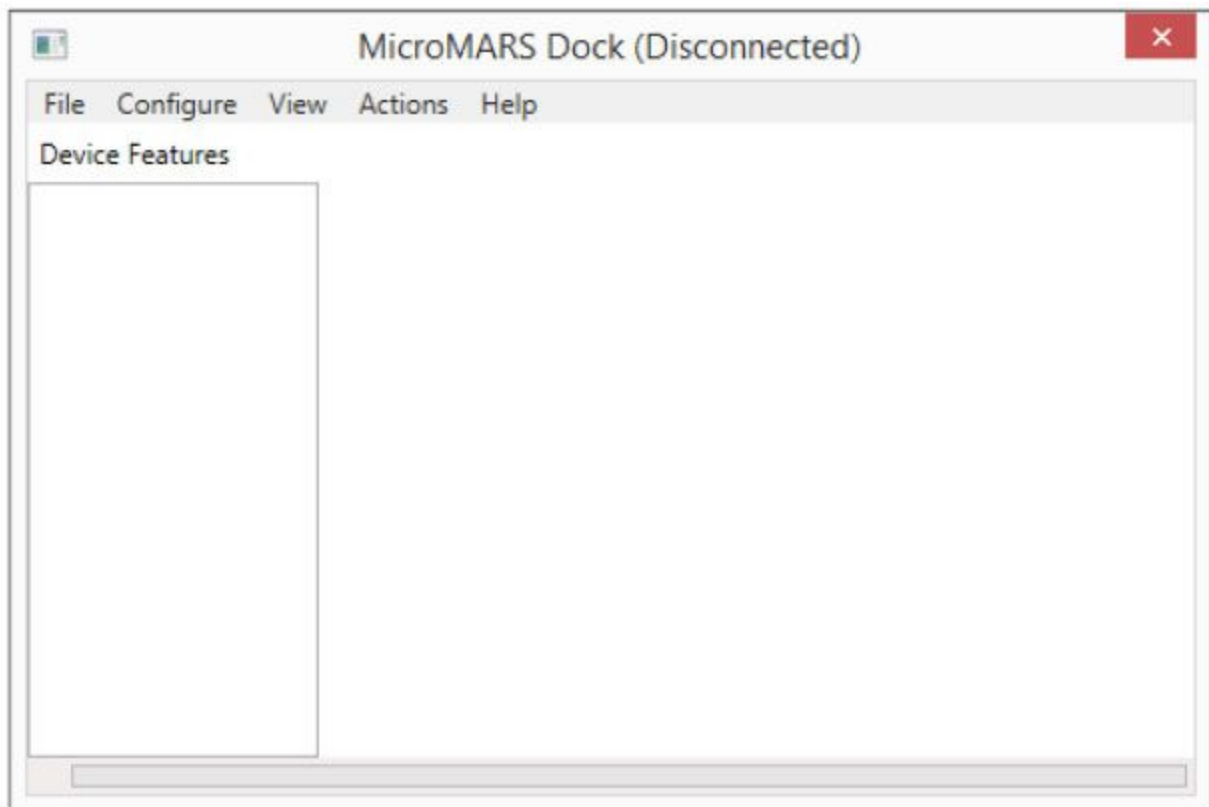
- Clicking “Format Device” button along with clicking “Yes” will finish configuring the microMARS device.

Plug in the battery before removing the USB cable. Battery must remain connected during the recorder assembly, or else the real-time clock will stop and reset to January 1, 1970.

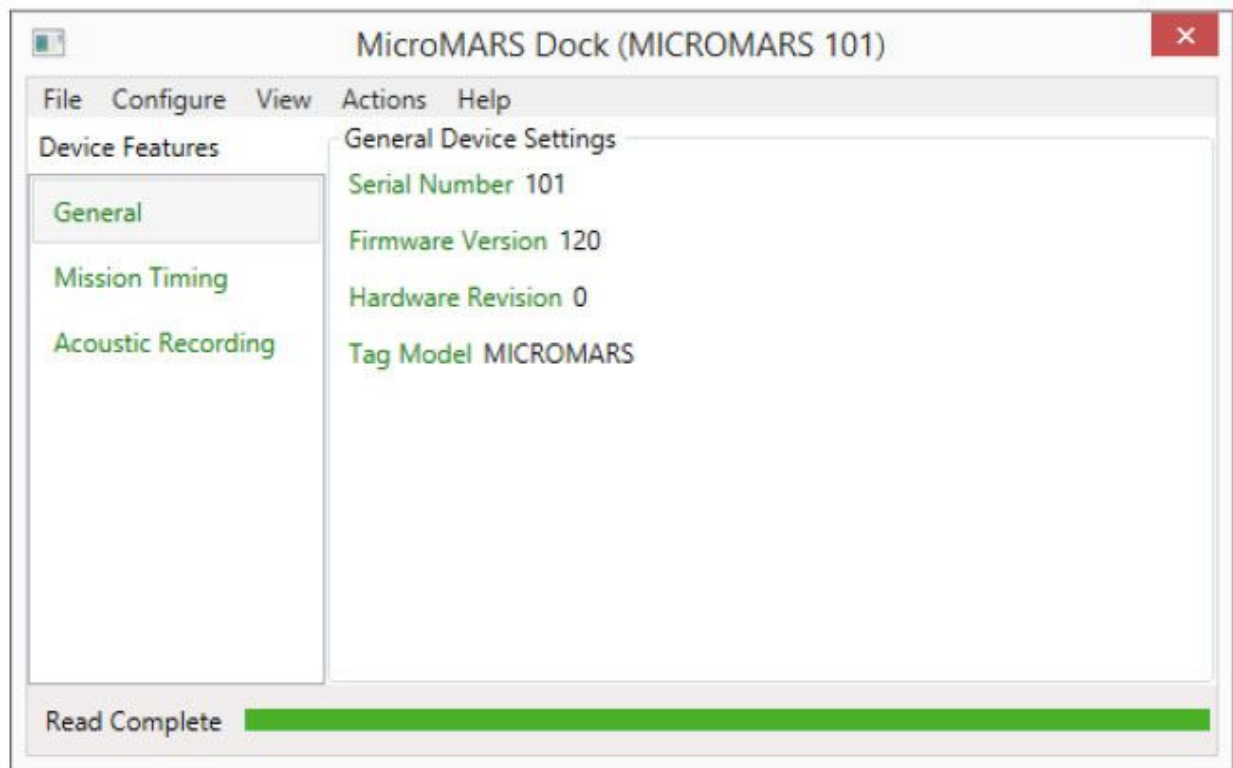
Monitoring Recorder Activity

microMARS sends out a variety of diagnostic messages that show its recording activity and identify any problems such as a non-formatted or a defective SD card. Monitoring activity after configuring and before closing up the recorder is, along with monitoring the LED pattern, a good method to assure the recorder is functioning.

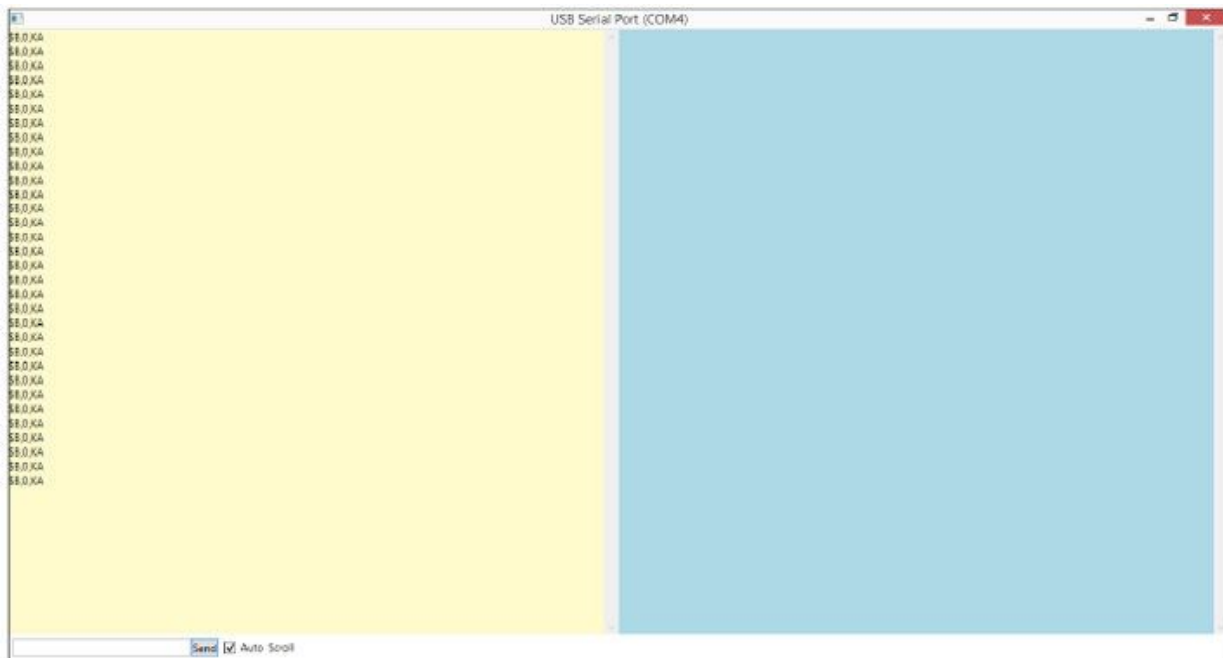
Once you are done with configuring the recorder, call up the Raw Coms window and type the command **\$B,0,EDR** (Exit Dock Request) into the command field in the lower left corner of the window. Then, hit the **Send** button. The screen shots below show how it's done and some of the messages that you will see.



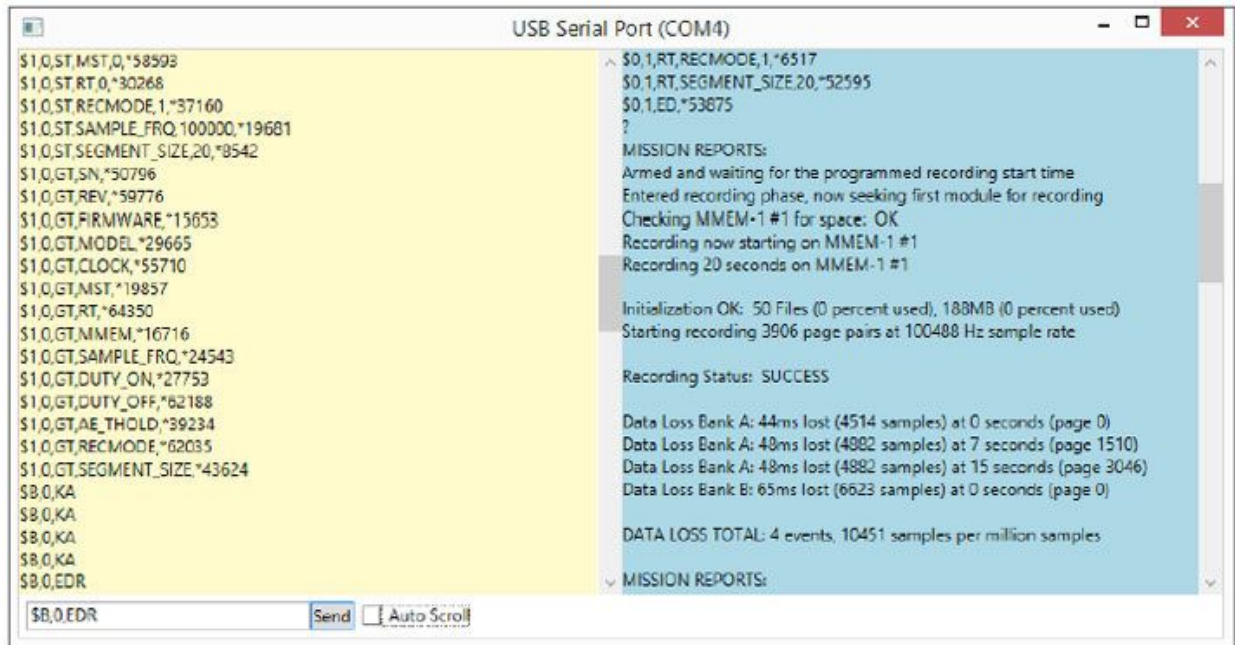
Click on "Actions" then "Connect Device."



After connecting user device, a “Read Complete” will appear at bottom of window in Dock software. Alternatively, at the top of the window in parentheses, the serial number of the device will appear, such as “(MICROMARS 101)” that is shown above.



The Raw Coms window will appear. Enter the command **\$B,0,EDR** and hit **Send**.



The image above shows some typical microMARS status reports. (Note some fairly significant data losses due to use of a slow SD card.)

LED Blink Patterns

Red LED (Recording)	
Sample Frequency	RED blink rate
(1 blink every) 500K samples per second	Once every 1 second
250K samples p/s	2 seconds
100K samples p/s	5 seconds
50K samples p/s	10 seconds

<u>Green LED (Standby)</u>	
Sample Size	Description
(1 blink every) 16 seconds	Standing by for recording: (1) Recording starts upon acoustic event detection OR (2) Recording starts in next Duty Cycle ON phase.
(1 blink every) 32 s	Ready-to-go state (pre-recording): Recorder will start recording once <u>Mission Start Time</u> is reached.
(1 blink every) 64 s	Done with recording.

- **No blinking:** No battery is inserted or battery is dead

Orange LED (Dock Mode)

The orange LED lights continuously once the recorder detects the USB connection and is ready to communicate with the user via the microMARS Dock software. After plugging in the USB cable and launching microMARS dock, wait until you see the orange light before using the Actions → Connect Device to link to the recorder.

microMARS Deployment & Anchoring

microMARS are easily deployed with minimal boat resources due to their small size and minimal weight. Small equipment size makes the deployment package smaller, as less flotation and less anchor weight is required. Small boat deployment and even kayak deployment is quite realistic, along of course with deployment from large vessels.

For auto-recovery, we recommend our ARC series acoustic releases. These small releases are well-sized for use with the microMARS, have a fast acting release, a ranging function to detect and home in on gear even if it got displaced, and a very strong reliability record with much use in larger applications such as fisheries and deployment of large instrument arrays.

In general, about 15-20 lbs of anchor weight is used, while flotation (a small hard float) is 3-8 lbs typical. The entire gear set is rated for deployment to and recovery from 300m depth. There are two versions of the ARC acoustic release:

1. The ARC-1 is a 'traditional' configuration, which leaves an anchor weight behind. The ARC-1 has been an active product since 2005 with over 1000 sold and thus a very high degree of refinement. It is described in good detail on our web site here:

ARC-1XD

2. The ARC-POP is a new pop-up buoy release. It pops a tethered buoy to the surface, and the entire mooring package is then recovered by collecting the buoy. It is based on the same mechanism and acoustic control functions as the ARC-1 and thus inherits its reliability in those aspects.

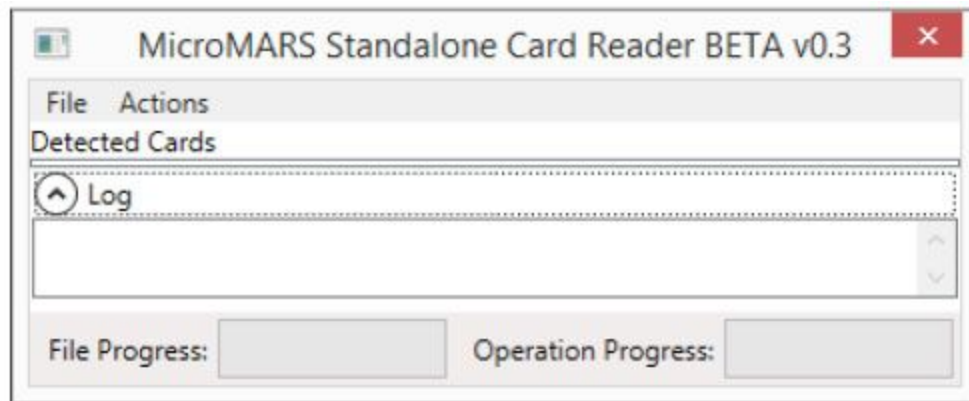
Data Retrieval



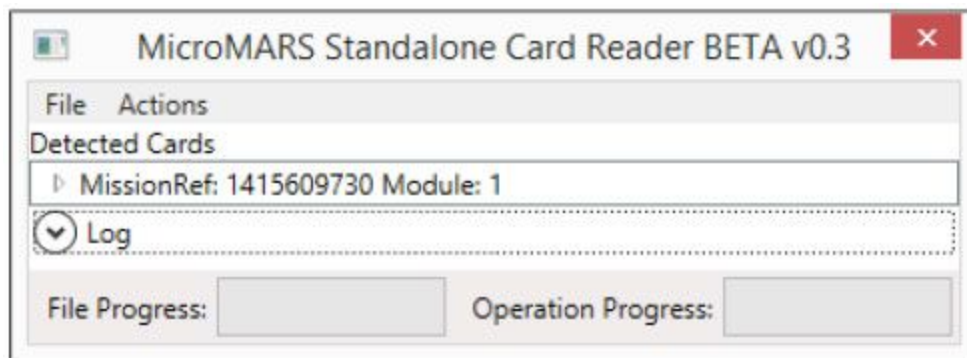
Referring to “Recorder Disassembly & Assembly for Configuration & SD Card Access,” follow steps to retrieve user data.

- Remove SD cards from recorder and plug into provided laptop via standard USB card reader dongles also supplied with recorder starter kit. microMARS records data in a ping-pong fashion on a pair of SD cards, and each of the devices hold up to four MMEM-1 memory modules in the electronics stack that hosts a pair of SD cards. Consequently, data is always retrieved by plugging a pair of cards into the PC. If the full eight SD card version of microMARS is used, all eight cards may be plugged into the PC via a USB hub, which is also supplied with the recorder starter kit.
- SD cards are removed from recorder and plugged into the PC in pairs. USB card readers are supplied with the microMARS starter kit (Figure 7).

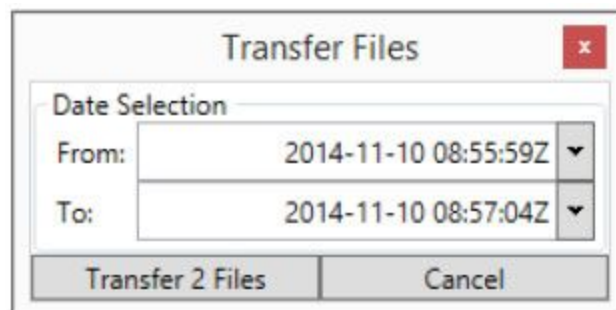
Open “microMARS Reader” to turn user data into WAV files from SD cards. After having desired SD cards chosen and plugged into provided user computer/USB ports and dongles, open Reader program to retrieve data.



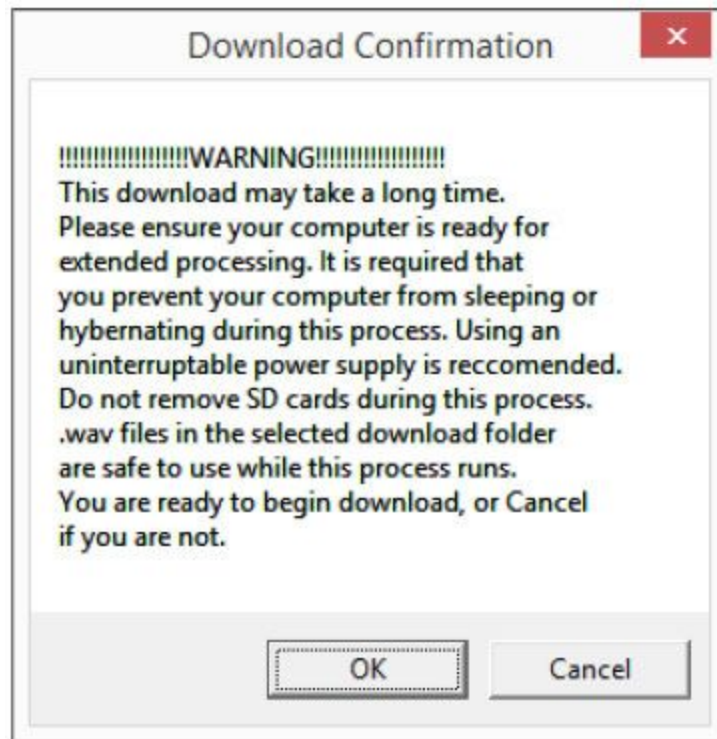
Click on “Actions” then “Detect Cards.”



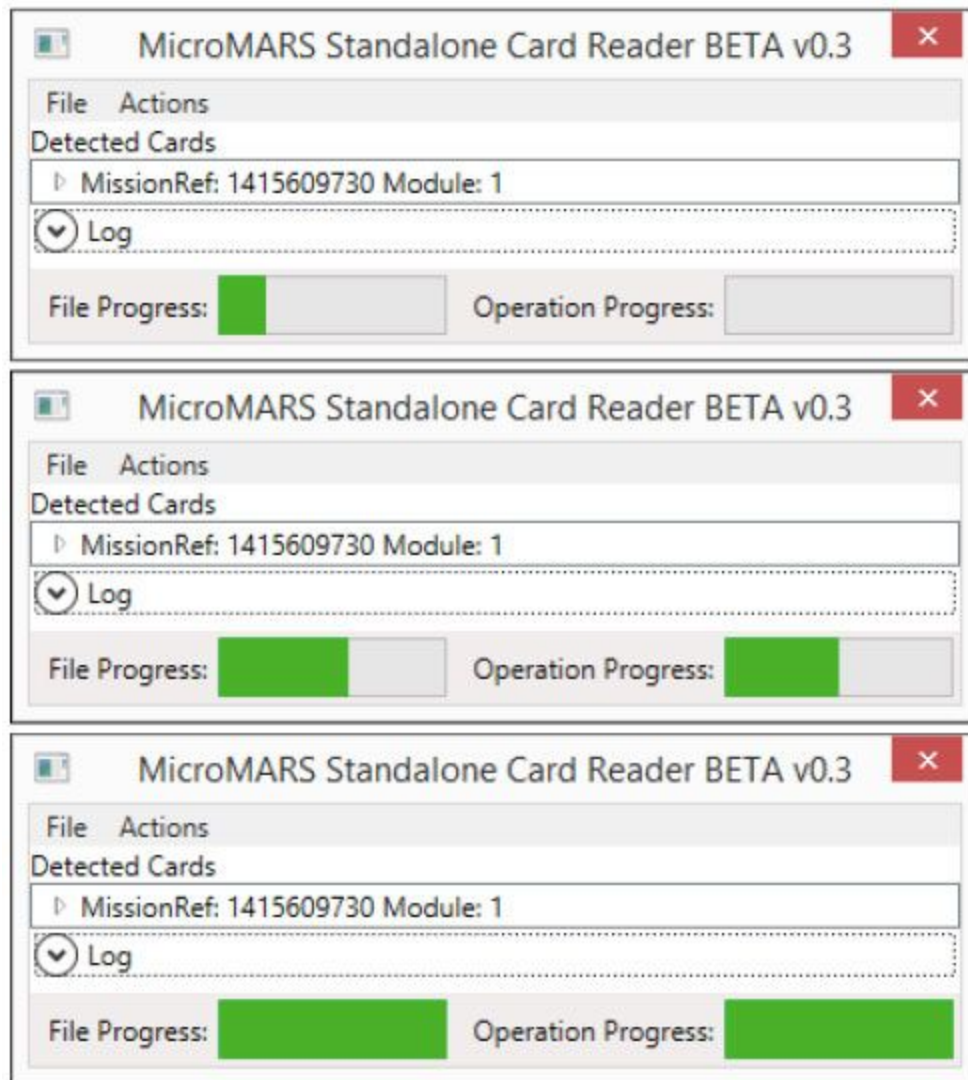
Select “Actions” then “Transfer Files.”



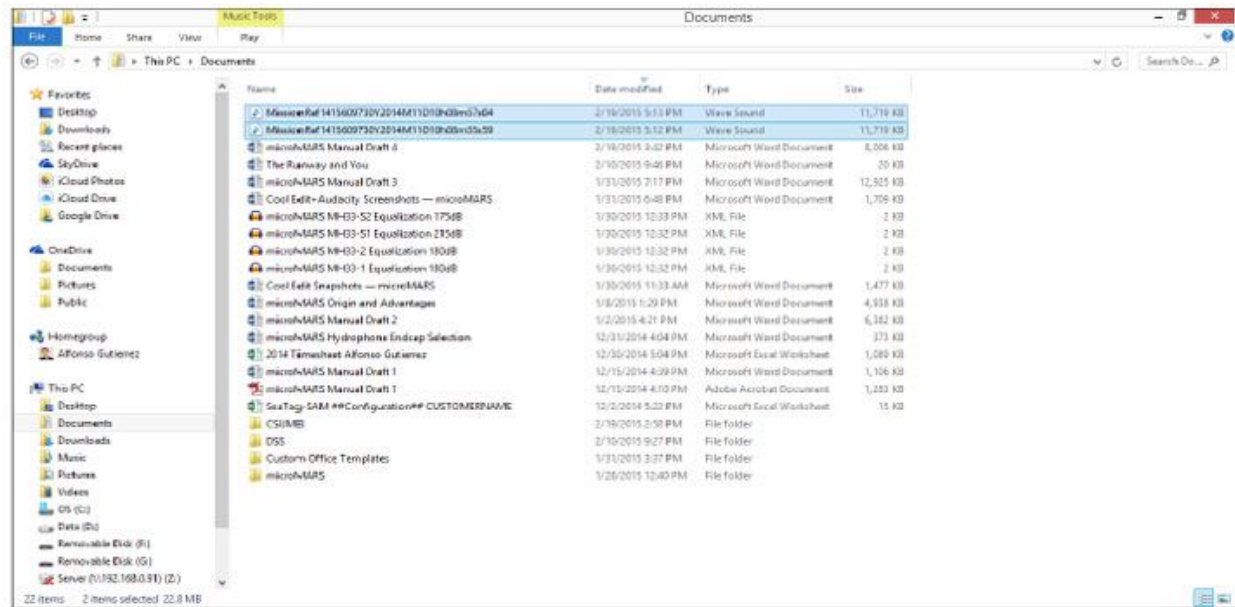
From the “Date Selection” shown, user may select desired date/time stamps for a specific data set, such as the “2 Files” shown. Or they may choose all of their data set.



“Download Confirmation” box will appear for user to choose to continue, or “Cancel” if not. Continuing will download user-selected data. Please heed text concerning downloads.



After selecting "OK" and a file destination, data will commence transferring.



After download has finished, open file(s) from previously selected file destination, as shown. User may select Cool Edit or Audacity (recommended) program if desired to open, edit, and/or view files.

Hydrophone End-Cap Selection

The sensitivity and frequency range of microMARS is set by the hydrophone end-cap. The end-caps, which cost around \$500, are easily replaceable. By keeping an inventory of end-caps, your recorders can be adapted for a variety of jobs.

Endcaps should be selected depending on the characteristics of the sound source (marine mammal, industrial noise, etc.) to be studied, and the expected ambient or background noise level. Here are the basic considerations.

Determine the highest frequency needed

The microMARS end-caps are built around piezo-electric resonators that provide a flat frequency response (uniform sensitivity) up to a specified frequency. The part number specified that frequency, such as MH33-xx for end-caps with a flat frequency response up to 33 kHz, or MH125-xx for end-caps with a flat response up to 125 kHz. Because end-caps designed for higher frequencies are also less sensitive, select the lowest frequency end-cap type that still covers your frequency range of interest. For example, to study killer whales or great whales and industrial noise that all occur below 33 kHz, select an MH33-xxx type. However, to study dolphins that vocalize at higher frequencies, select an MH125-xx for operation up to 125 kHz.

Select Flat or Sloped Frequency Response

Flat Frequency Response: Underwater recorders are traditionally optimized to provide a flat frequency response, i.e. uniform sensitivity across the operating frequency range. The principal advantage of a flat frequency response is that the resulting .WAV files can be used directly to generate dB re. 1 μ Pa (or equivalent) referenced spectra, perform various sound measurements or play the files with a 'natural' sound quality. Hydrophones with a flat frequency response are designated by a number directly after the dash, such as MH33-1 or MH33-2. The -1 or -2 defines the gain programming of the hydrophone, which determines both the maximum signal the hydrophone can receive without clipping, and the noise floor.

Sloped Frequency Response: Sloped frequency response hydrophone end-caps increase in sensitivity with frequency. At low frequencies, they are less sensitive and can thus accommodate louder signals without clipping. At high frequencies, sensitivity is greater and the noise floor is lower, meaning that fainter signals can be detected. This sloped frequency response matches the typical noise profile in the ocean, with lower frequencies experiencing louder noise. Thus, by selecting a sloped frequency response end-cap, you may be better able to measure loud industrial noises without clipping while at the same time detecting faint biological signals such as from distant marine mammals vocalizing at higher frequencies. In other words, a sloped frequency response end-cap provides a greater dynamic range (great ratio of loudest to weakest discernible signal) than is available with a flat frequency response end-cap.

The downside of the sloped frequency response is that for most uses of the data, the .WAV files generated by microMARS must first be equalized, a process in which frequencies at which the hydrophone is less sensitive (low frequencies) are boosted relative to frequencies at which the hydrophone is more sensitive (high frequencies). This process however is performed quickly and easily by Audacity, a free open-source software available on-line. An Audacity compatible equalization curve is provided for each hydrophone configuration by Desert Star Systems. This curve also automatically 'normalizes' your sound files to a certain value, such as 180dB re. 1 μ Pa full scale for MH33-1 and MH33-2, 215 dB full scale for MH33-S1 and 175 dB full scale for MH33-S2.

Select to Accommodate the Strongest Expected Signal

Figure X1 shows the frequency-specific full-scale value for the four MH33-xx standard configurations along with observed loudness for a selection of events. In order to avoid signal clipping (i.e. signal exceeding the full-scale value), select a hydrophone configuration where the clipping curve is above the expected signal.

For example, MH33-1 can accommodate an environment with strong snapping shrimp, while the shrimp clicks would be clipped when using MH33-2 or MH33-S2. To monitor pile driving (a loud industrial noise) at 330m distance, MH33-S1 would be compatible but to monitor at 7m distance a special configuration not listed here would be needed.

The sound observations here can be corrected for other distances by subtracting 6dB for each doubling of the distance or adding 6dB when halving the distance. At 10% of the observation distance, the expected signal is up 20dB, and at 10X the observation distance, it would be down 20dB. For example, the ferry at 1000m had an observed noise level of about 150dB with a signal

peak around 0.4 kHz. This signal is actually compatible with all MH33-xx configurations. However, at 100m distance, the signal would be around 170dB, requiring either MH33-1, or MH33-S1.

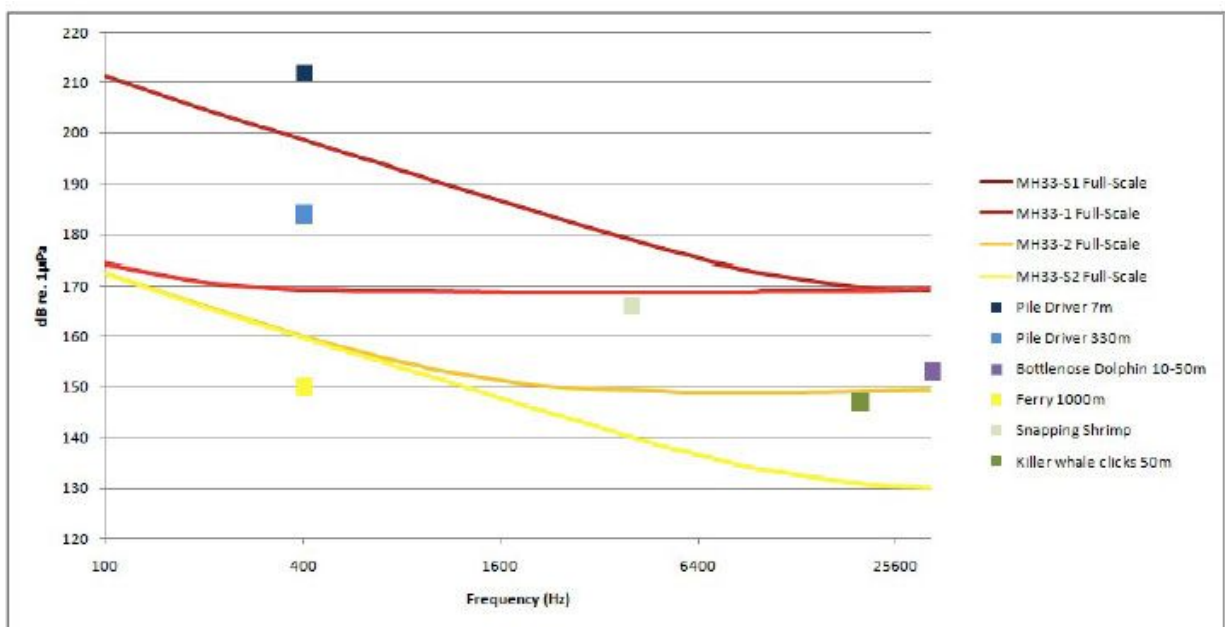


Figure X1: Full-scale sound curves for MH33-xx hydrophone end-caps with some sound observations.

Select for Best Weak Signal Performance

If the only selection criteria were strong signal performance (above), one would always select the MH33-S1 configuration among the MH33 types. This hydrophone can accommodate all but the strongest observed signals without clipping. However, this hydrophone also exhibits the highest noise floor or self-noise, as shown in figure X2. Conversely, configuration MH33-S2 with the lowest full-scale or clipping value offers the best (lowest) noise floor. Therefore, there is a trade-off: Select configuration MH33-S1 or MH33-1 to accept the loudest signals, but MH33-2 or MH33-S2 to get the best low-noise performance and thus detect a sound source at the greatest distance.

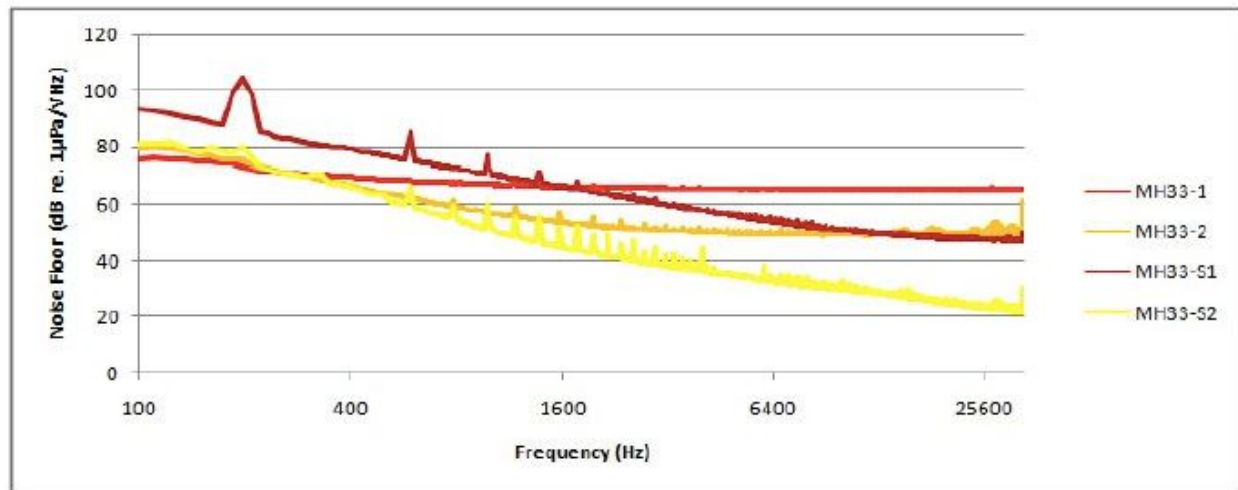


Figure X2: Noise floor of MH33 hydrophone end-caps.

In order to judge this trade-off, consider the ambient or background noise level at the observation site. If the hydrophone's noise floor is less than the ambient noise level, the ambient noise is the limiting factor and there is little point in selecting a more sensitive hydrophone. Typical noise in the ocean is described by the Wenz curves (Figure X3). While actual conditions may vary strongly, these curves provide a good starting point. As an example, consider recorder use to monitor Killer Whales in calm waters such as the Salish Sea. From figure X1, we observed their clicks center around 25 kHz, where the Wenz curves predict noise down in the 20-30 dB range for low sea states. Consequently, use of the MH33-S2 configuration, which also reaches down into the 20dB range at these frequencies, can potentially increase the detection range. However, the high sensitivity of MH33-S2 is then expected to cause signal clipping when the animals are within 500m or so. Yet, if the location exhibits high ambient noise such as due to snapping shrimp or small boat traffic, (small boat engines cause high frequency noise due to cavitation around the fast spinning propeller), MH33-S2 may be too sensitive and it may be better to select MH33-2 or even MH33-1 to get better close range performance.

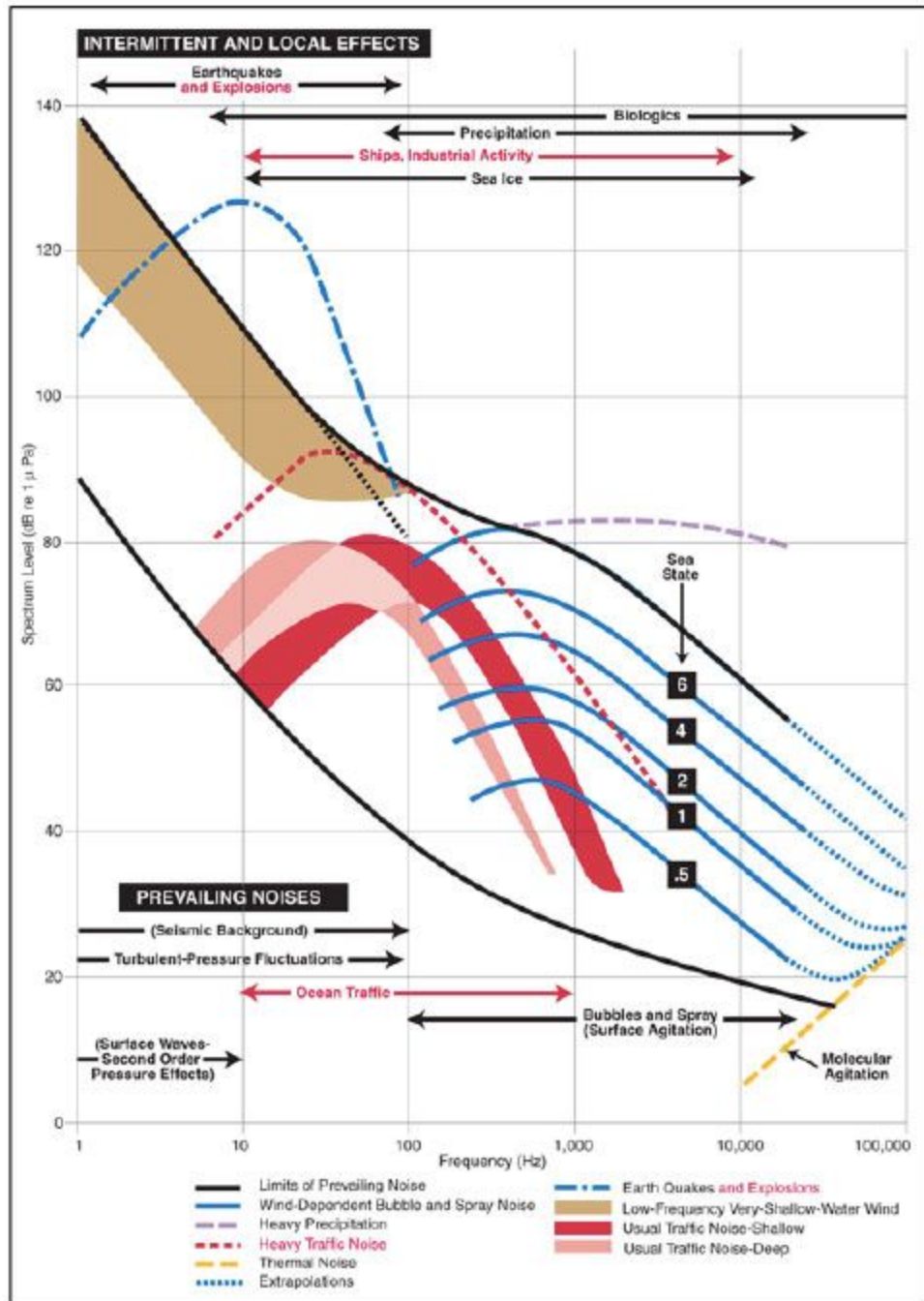


Figure X3: Wenz Curves for Ambient Noise in the Ocean

(Source: National Research Council, National Academy of Sciences)

MH33 Hydrophone End-Caps

The MH33 series of hydrophone end-caps are specified for use at frequencies up to 33 kHz. As compared to higher frequency end-caps, they offer better sensitivity. The end-caps include an integrated preamplifier, which is factory programmed for flat or sloped frequency response. High sensitivity types (MH33-2 and MH33-S2) are available for extended range monitoring in quiet waters. Medium sensitivity MH33-1 is for general use. Due to its sloped frequency response, MH33-S1 provides very high full-scale capability at low frequencies to monitor loud industrial noise while at the same time offering good sensitivity at high frequencies to monitor biological sounds such as marine mammal vocalizations.

Audacity compatible equalization curves are available for all hydrophones, and yield a flat frequency response and a defined full-scale value post-equalization. Please note that equalized files should be saved in 24-bit .WAV format (rather than 16-bit) to avoid loss of very weak signals.

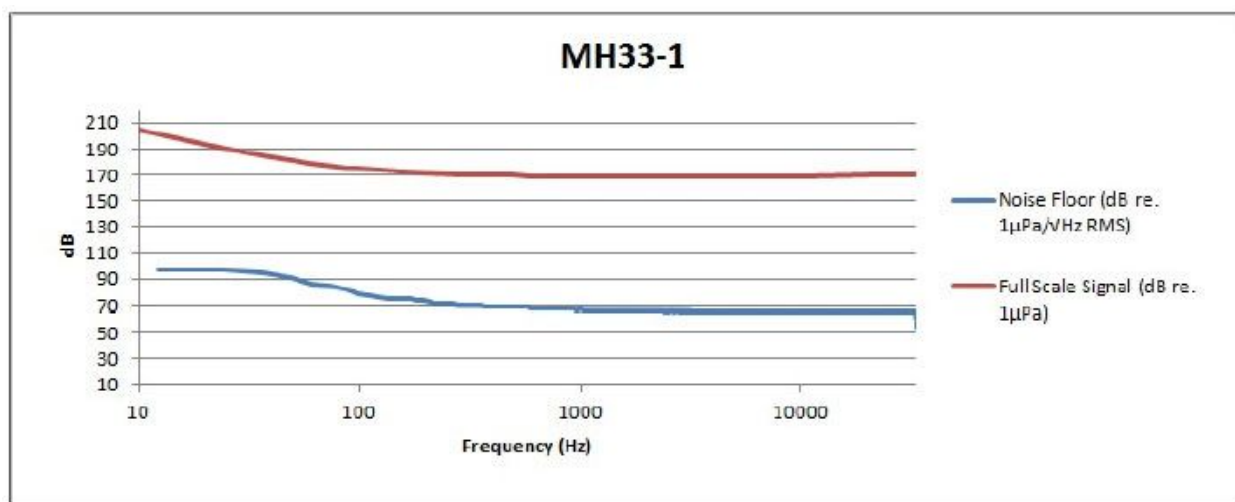


Figure X4: MH33-1 hydrophone end-cap for general use

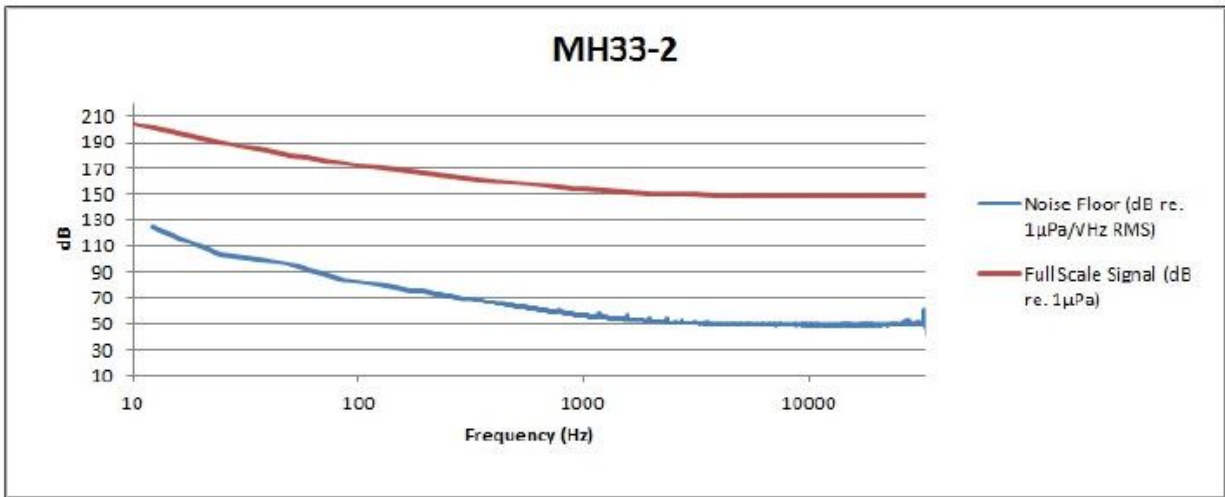


Figure X5: MH33-1 hydrophone end-cap for improved sensitivity in lower noise waters

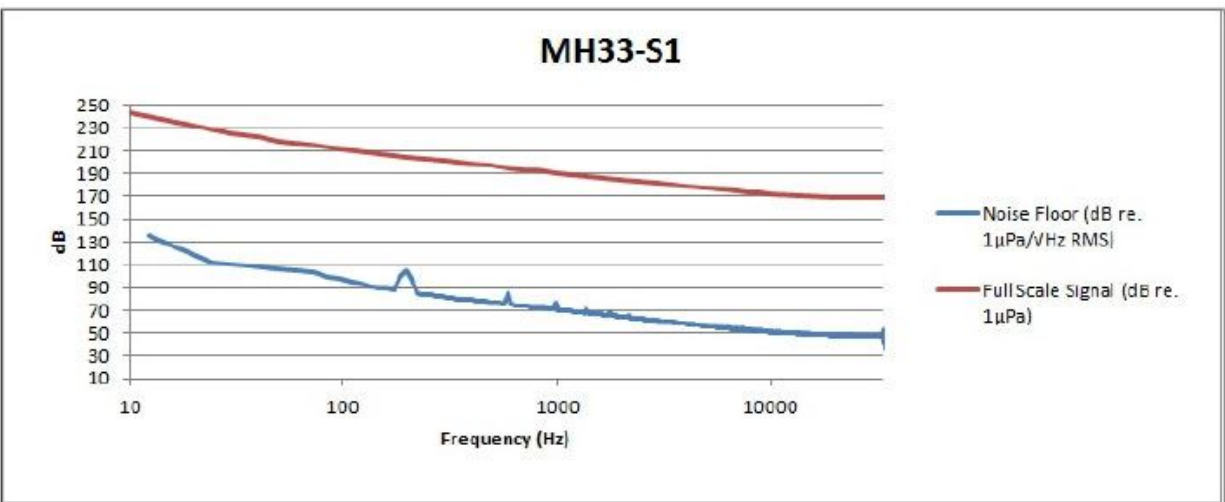


Figure X6: MH33-S1 sloped frequency-response hydrophone end-cap for simultaneous monitoring of loud industrial low-frequency noise and weaker biologicals at higher frequencies

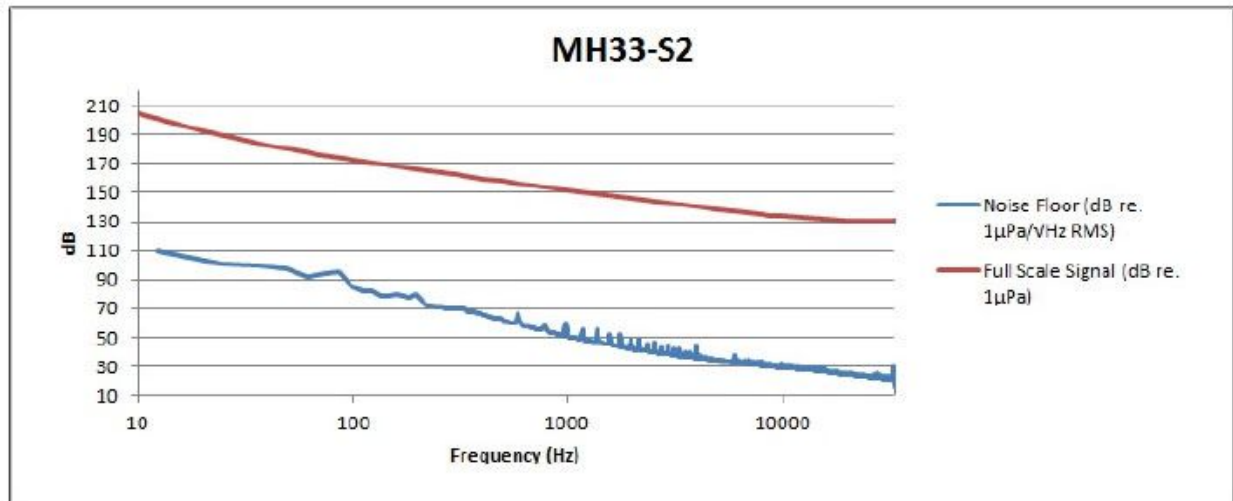
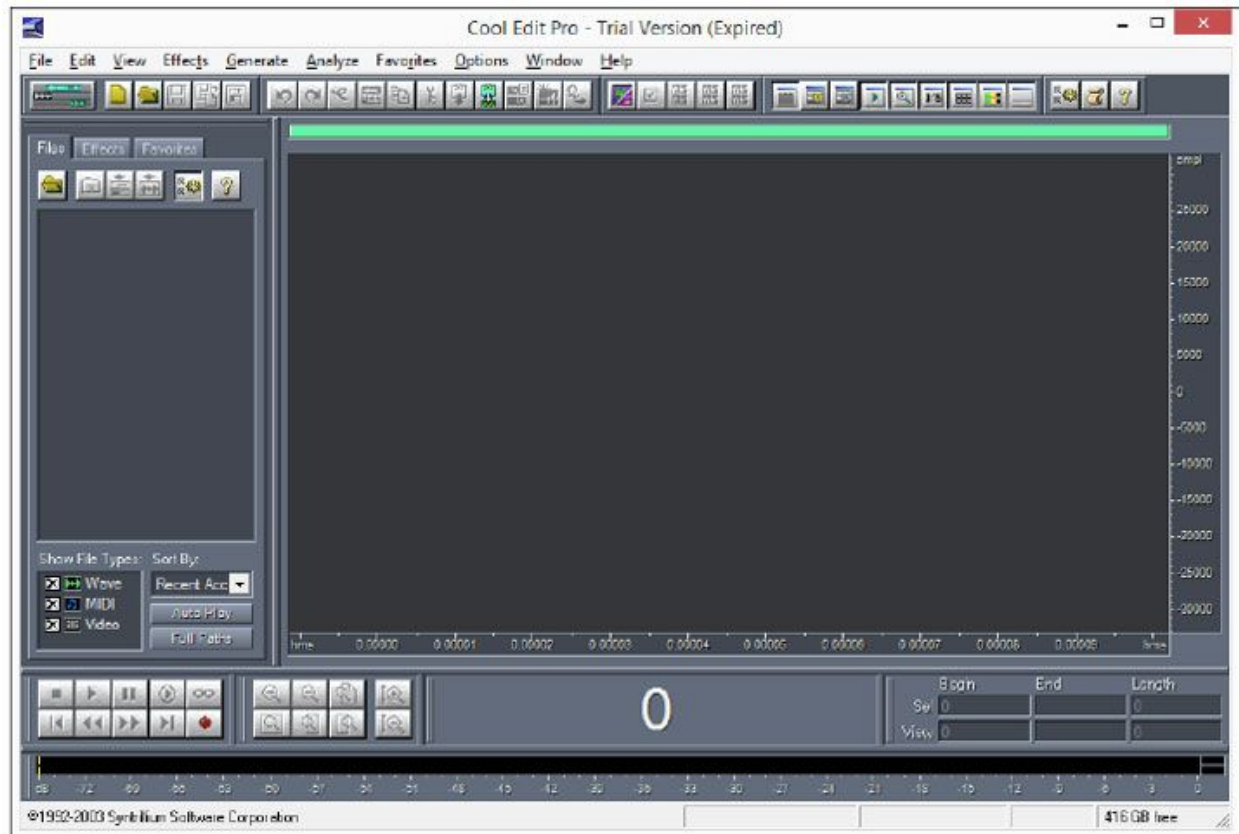


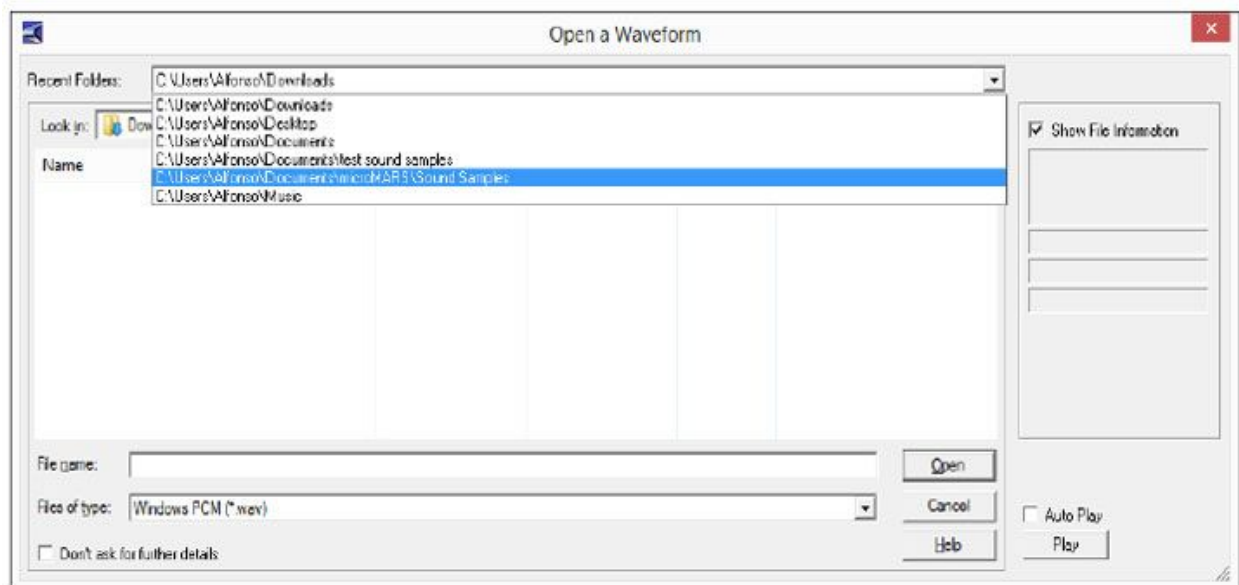
Figure X7: MH33-S2 sloped frequency-response hydrophone end-cap for extended range monitoring of weak high frequency signals and higher full-scale signal capability at low frequencies to reduce clipping in the presence of ship and other noises

Data Processing

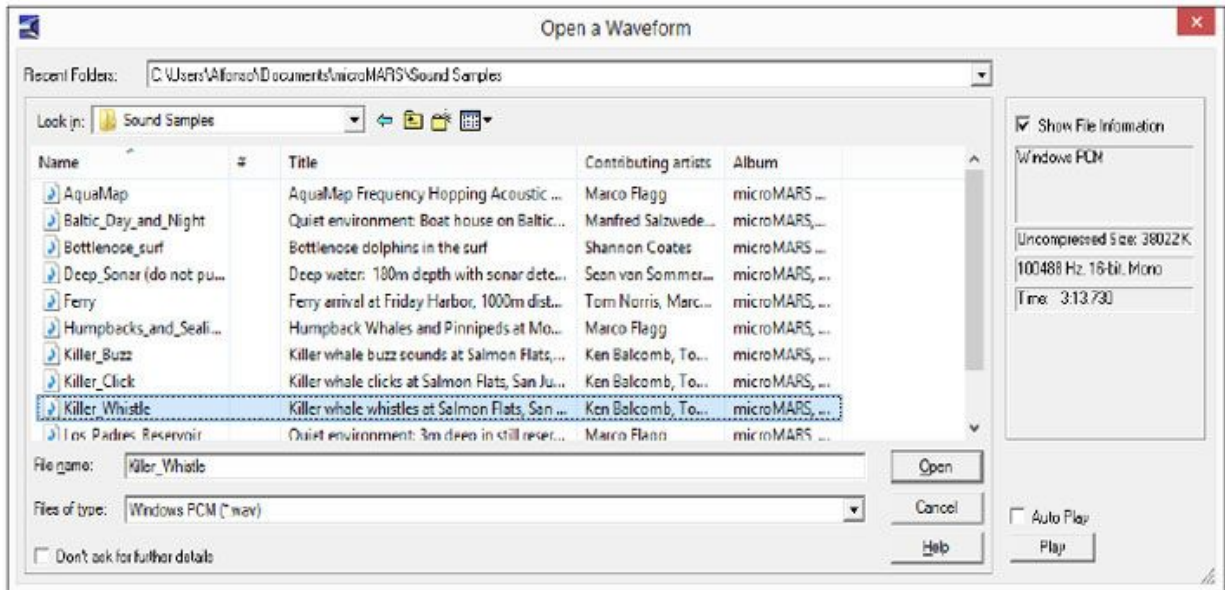
Viewing Acoustic Recordings with Cool Edit



Open the preinstalled Cool Edit Pro software from the provided laptop.



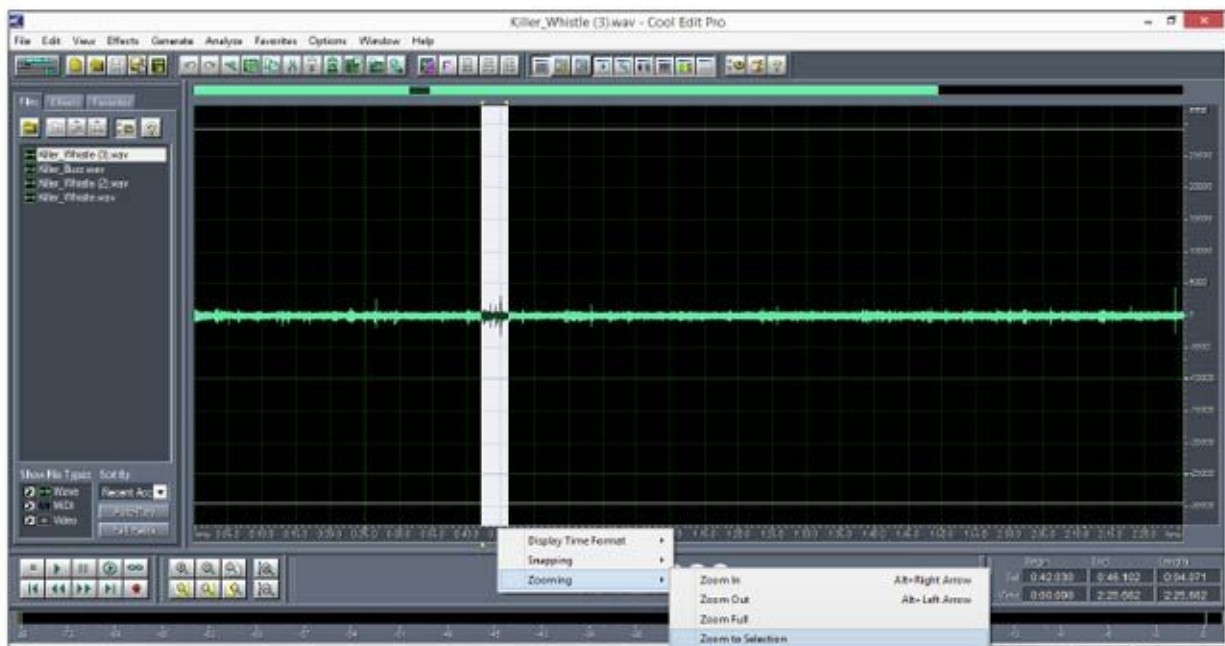
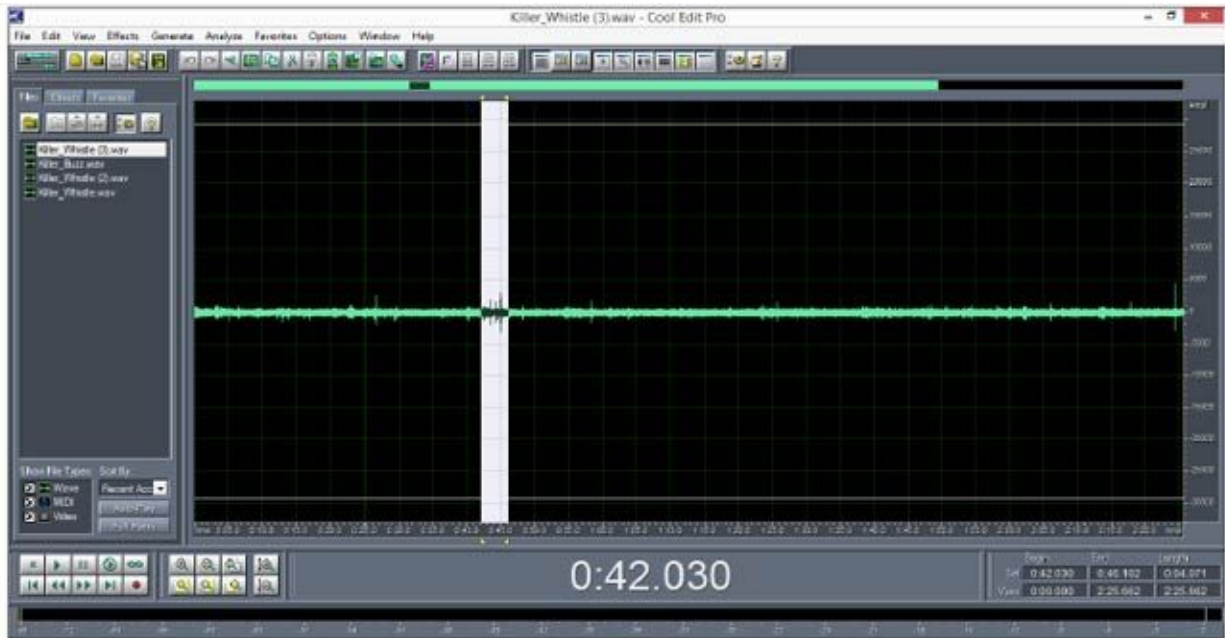
Go to “File” then “Open” to select a sound sample from user laptop.



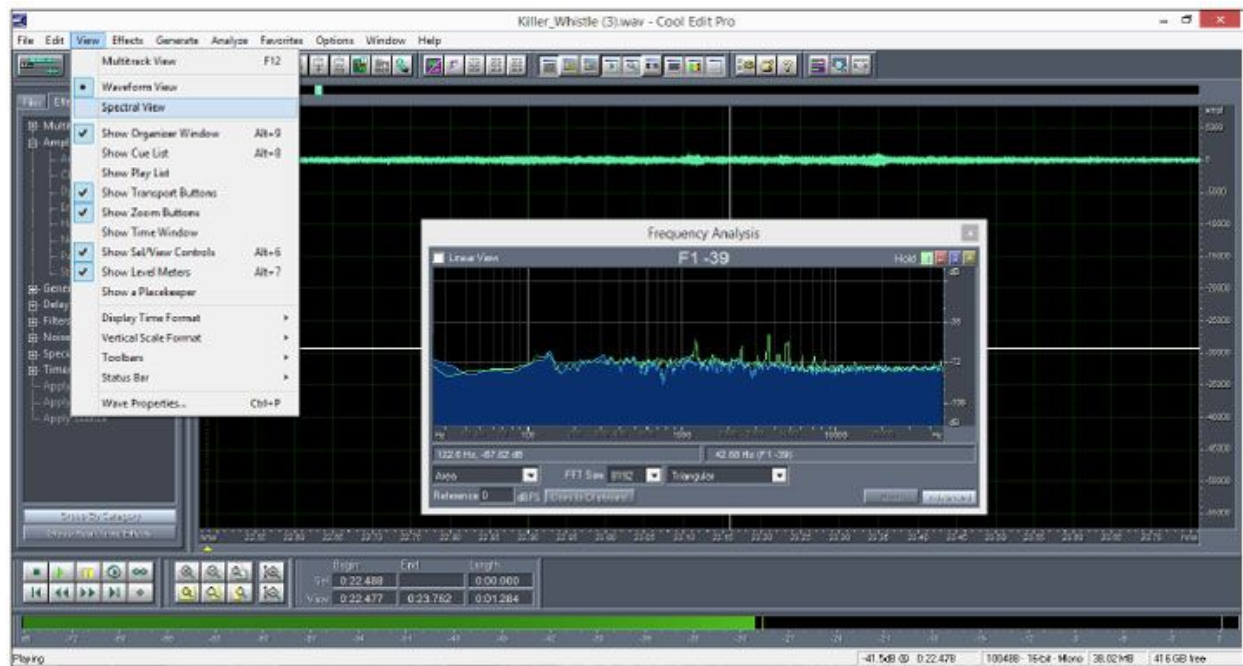
As above, find and select desired sound sample.



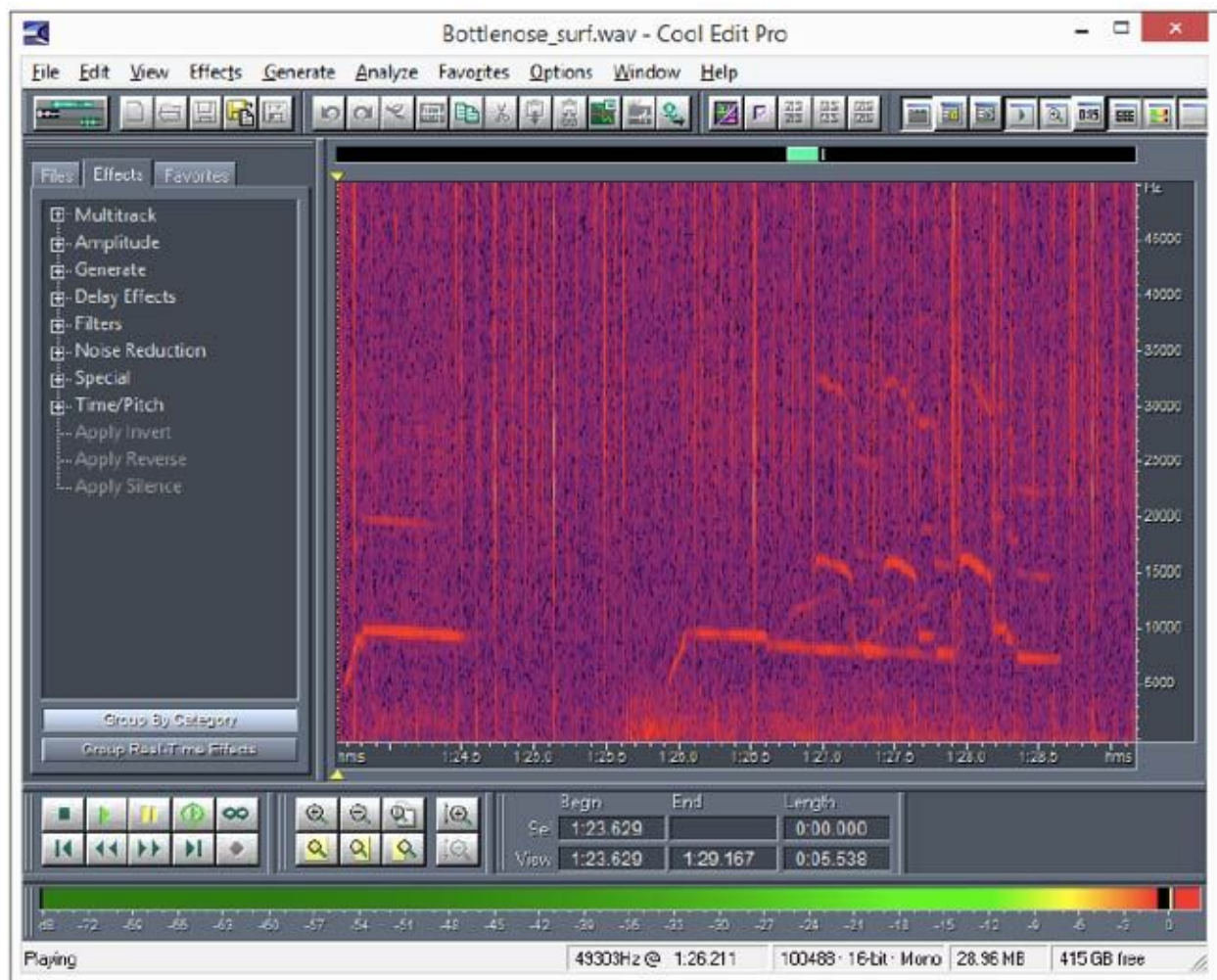
A selected sound file will appear in a light neon green hue, as seen above.



Highlight a specific area of selected sound file, and then right click on “Zooming.” Next click on “Zoom to Selection.”



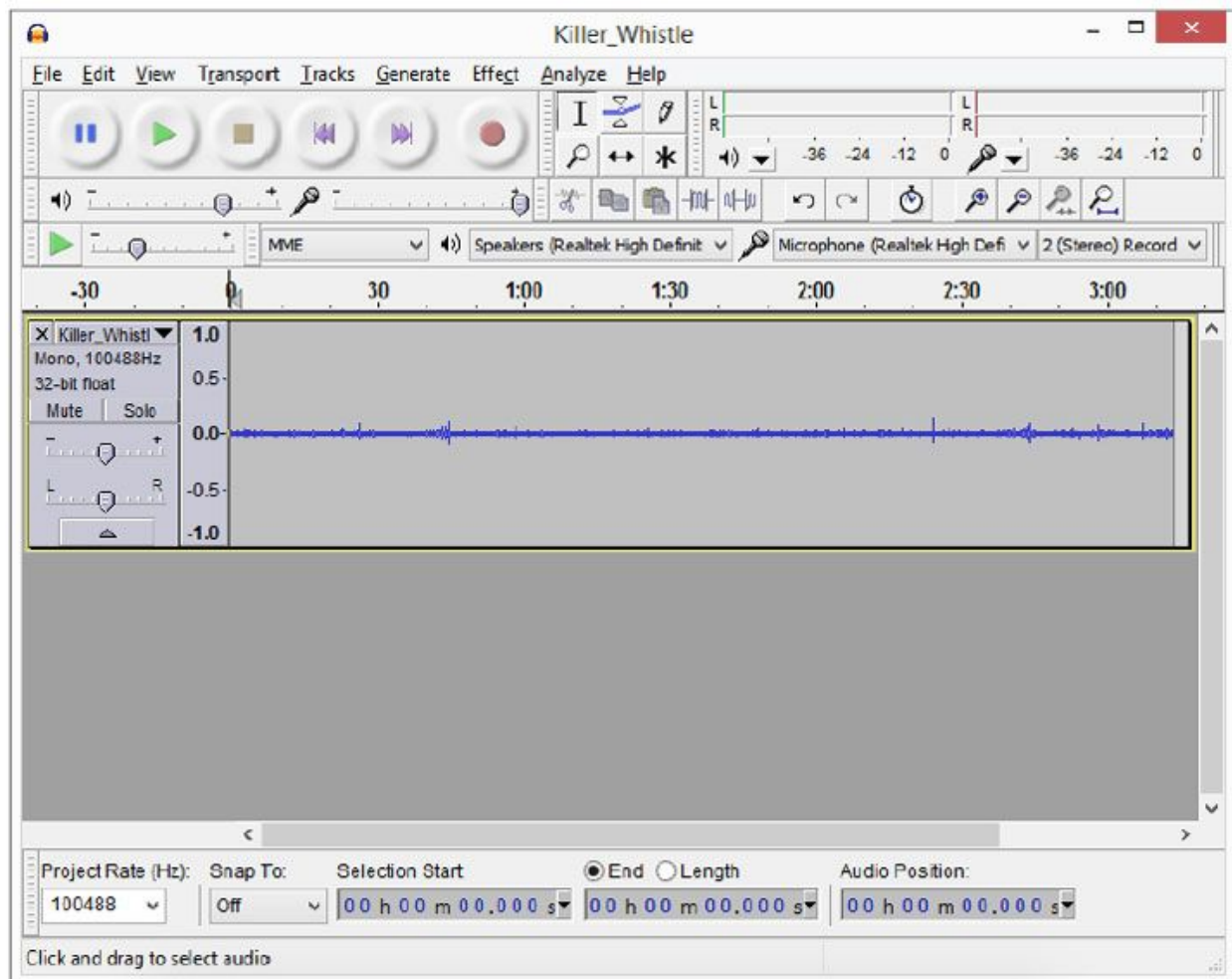
To select a spectral view of a sound sample, click on View then “Spectral View.”



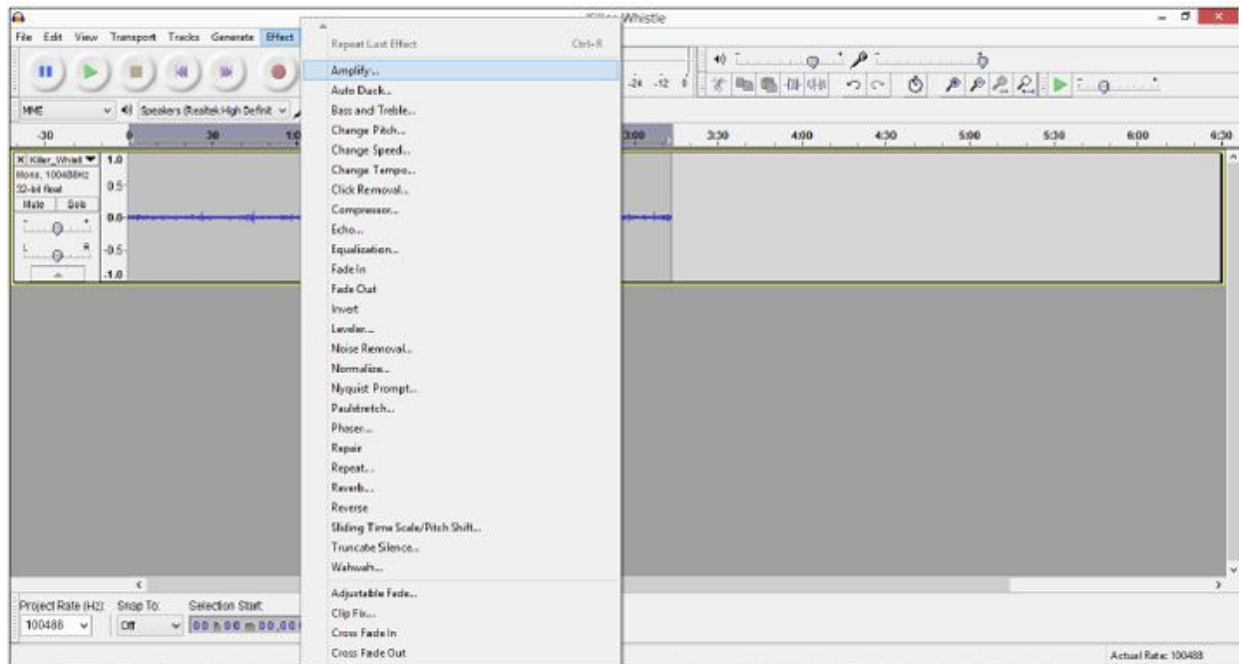
As shown above, Spectral View shows the spectral or frequency content of user recording as it changes over time.

The above example shows bottlenose dolphin whistles (distinct horizontal lines) interspersed with dolphin echolocation clicks (vertical lines.). This display has time on its horizontal axis, frequency on its vertical axis, with the signal power at any frequency indicated by brightness. The display will scroll as you play the recording.

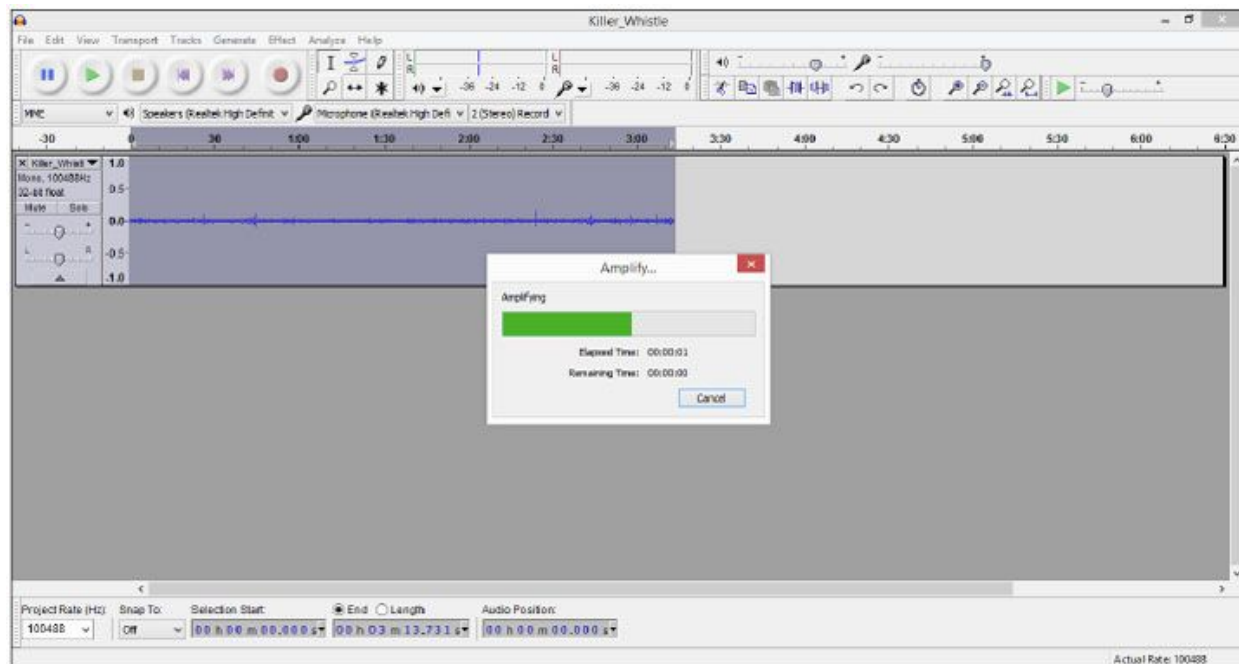
Equalizing Acoustic Recordings with Audacity



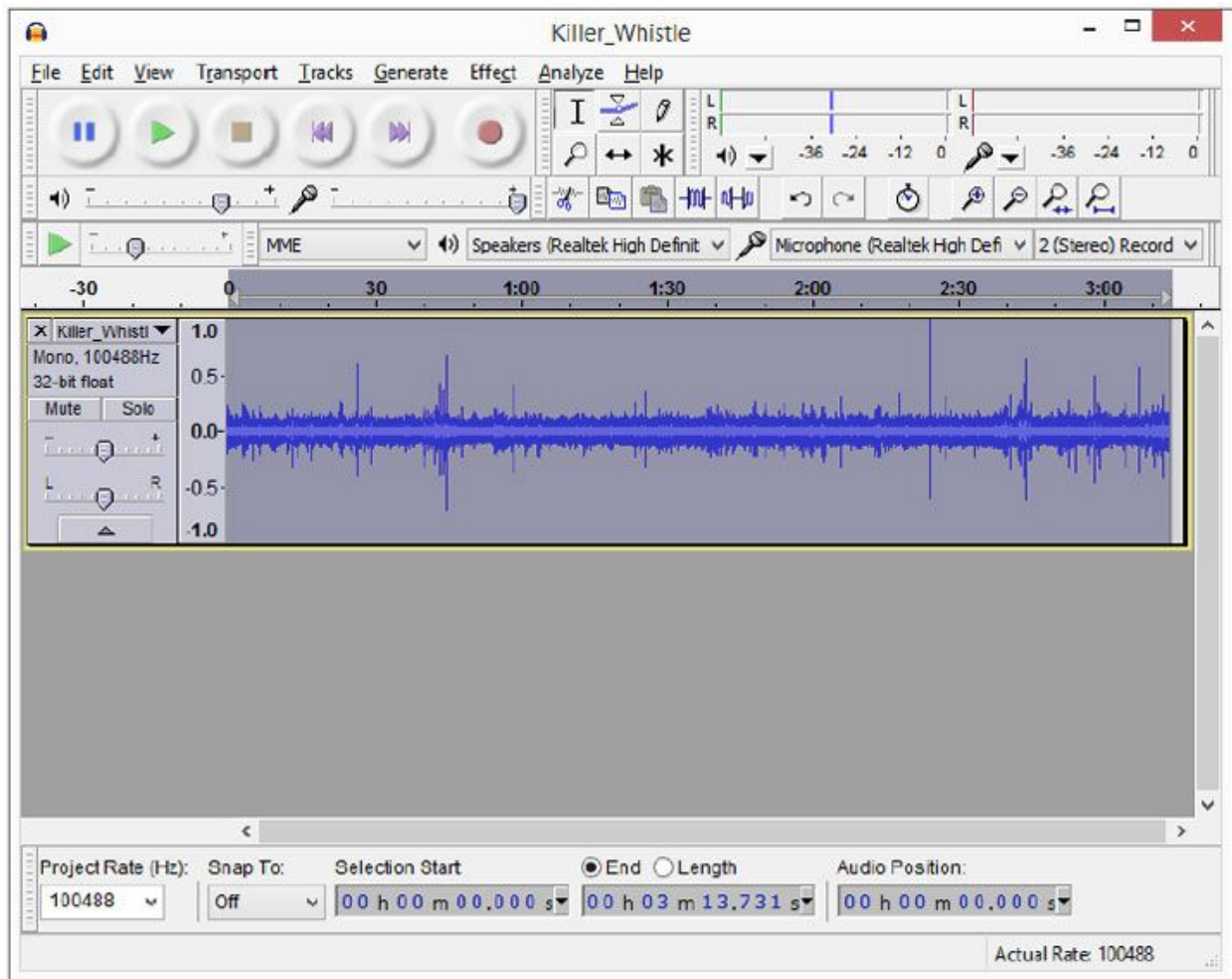
Open Audacity program saved on user device. Select desired sound file.



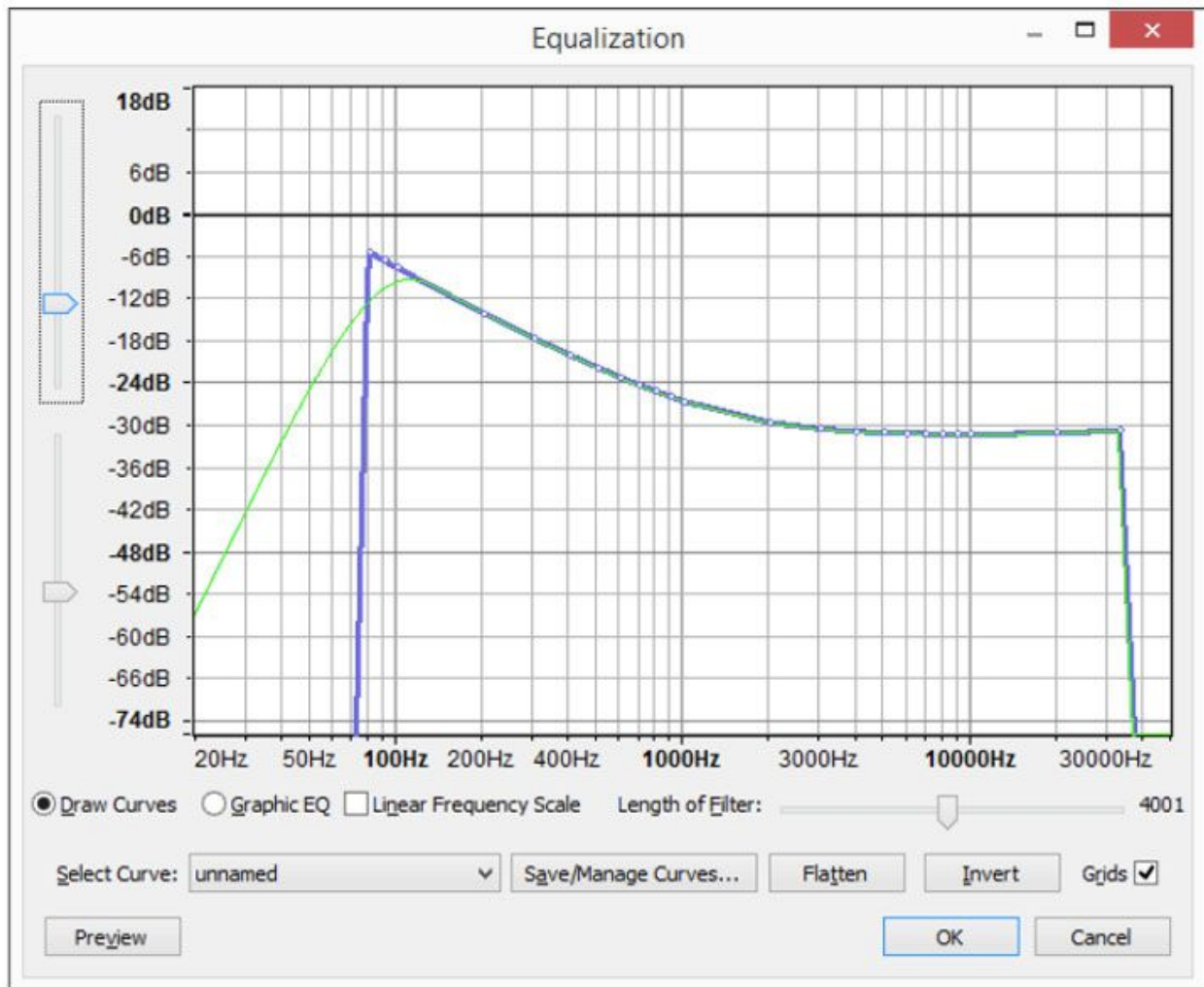
If user wishes to amplify a sound file, select “Effect” then “Amplify.”



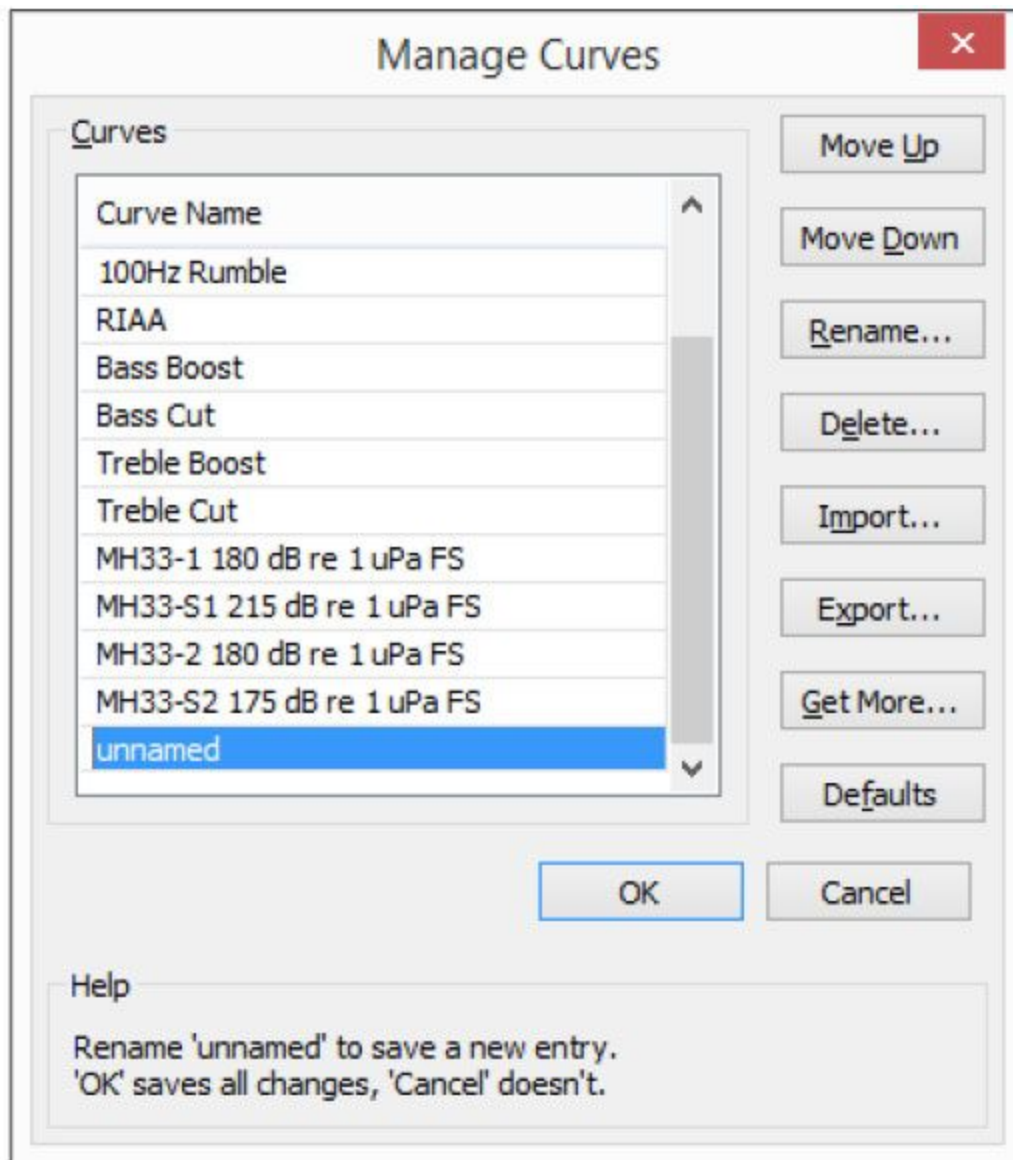
Notification will appear to show selected sound file being amplified.



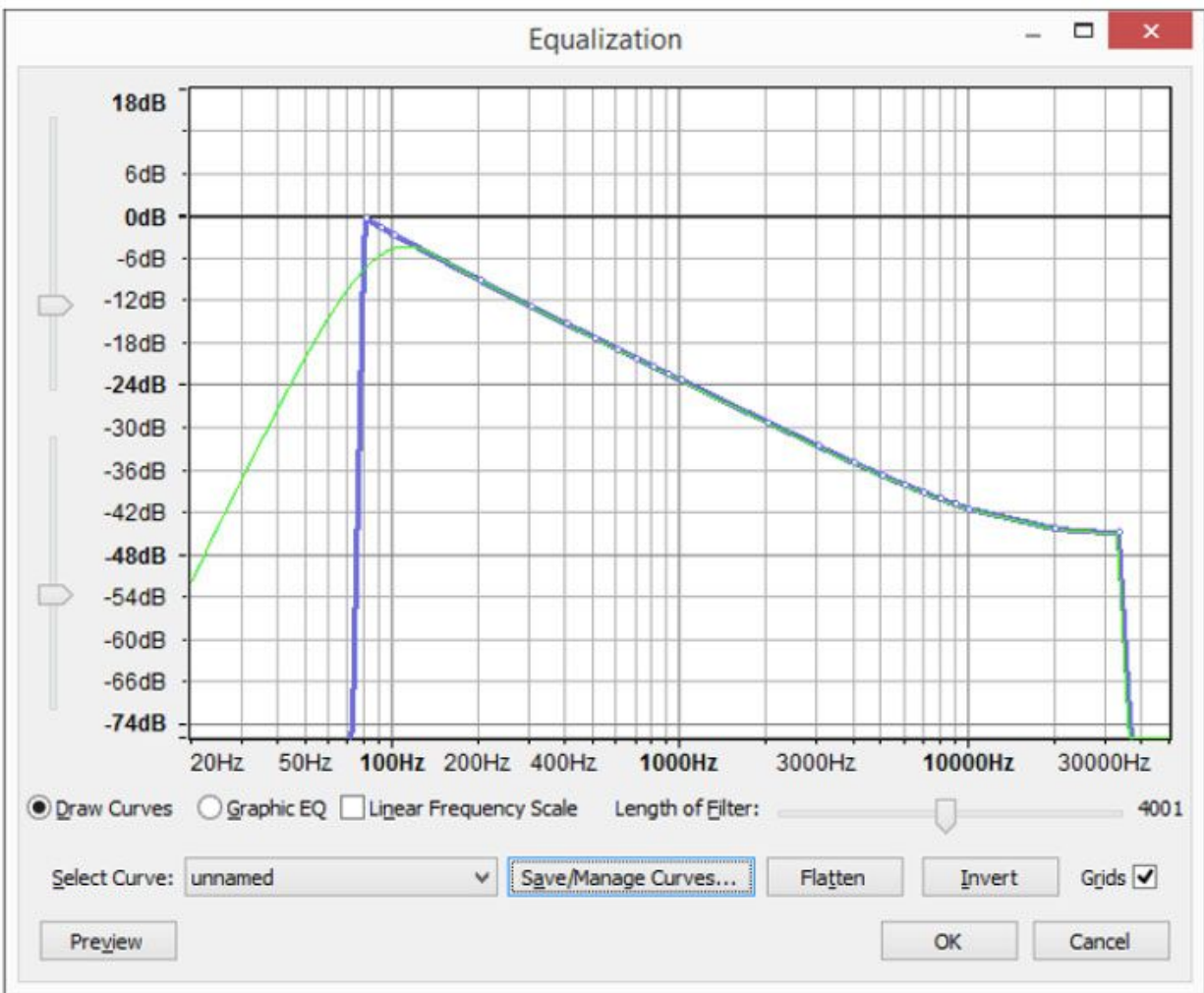
Selected sound file is now amplified.



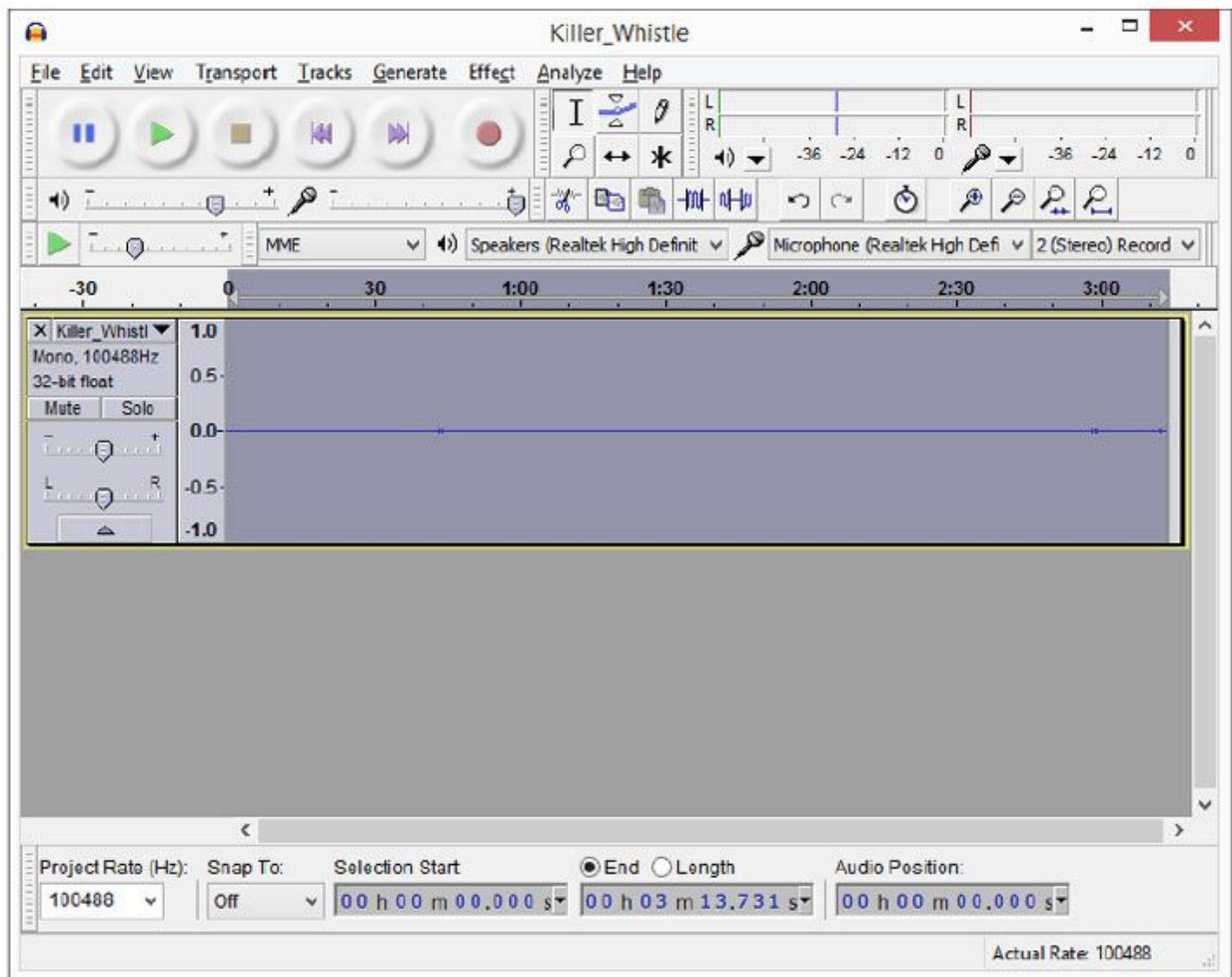
To equalize, select "Effect" then "Equalization."



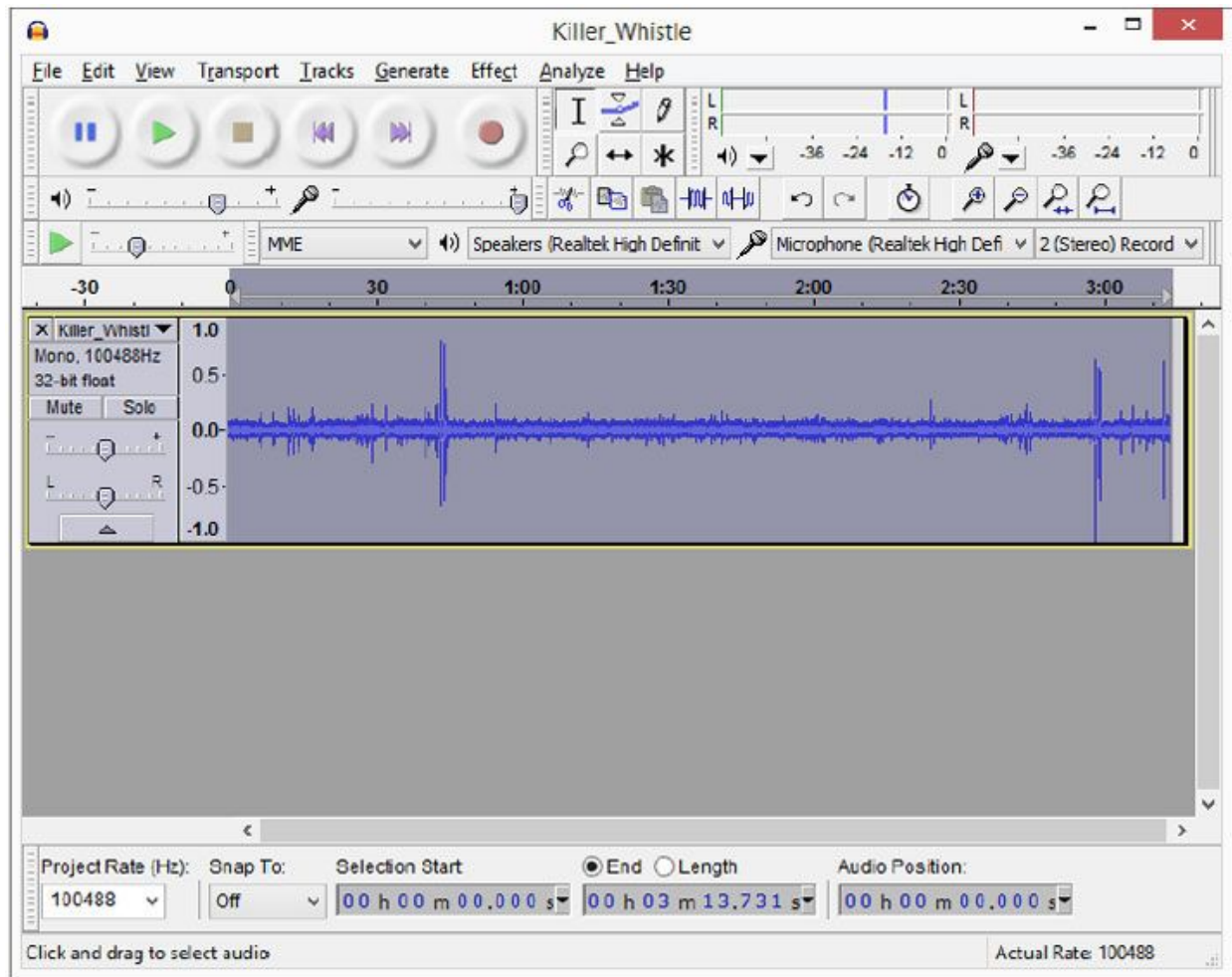
To continue equalizing, select “Save/Manage Curves,” then select the “Import” option. From there, select desired equalization file, such as those already seen from the “Manage Curves” screenshot above (e.g., “microMARS MH33-1 S2 175 dB re 1 μ Pa FS”).



The equalization file "microMARS MH33-1 S2 175 dB re 1 μ Pa FS" was chosen for the screenshot seen above. Next, press OK to apply user settings to original selected sound file.



Screenshot above displays "flat line" from the equalization of the selected sound file.



If user wishes to amplify selected sound file after equalizing, amplify by clicking on “Effect” then “Amplify.”

Technical Specifications



A. Parts List

Part number	Description	Quantity
HOU01654	Electronics end-cap	1
HOU01653	Hydrophone end-cap	1
HOU01655	Housing tube	1
ORI00046	O-ring	2
HDW00790	4-40 titanium Allen head screw (to secure end-caps)	12
HDW00474	Attachment loop	2
HDW00791	8-32 titanium Allen flat head screw (to secure attachment loop)	4

<u>B. Starter Kit Parts List</u>		
Part Number	Description	Quantity
MOD00032	USB hub	1
MOD00033	SD Card to USB adapter	8
ORI00046	O-ring	4
HDW00790	4-40 titanium screw	12
SSS00092	Silicone grease	1
CBL00058	USB Mini cable	1
CAS00006	Yellow Supply case	1
ARC-BAT2	3x AA Battery holder	1
TOL00054	O-ring removal tool	1

<u>C. Recorder Specifications</u>		
Parameter	Single Battery Version	Four Battery Version
Size	196mm L x 63mm D	399mm L x 63mm D
Weight in air (w/ lithium battery)	673g	1294g
Weight in water (w/ lithium batteries)	58g	28g

Housing Material	Delrin with Titanium hardware (non-corrosive)	Same
Depth Rating	300m	Same
SD Card Slots	Two cards (-2 version) Eight cards (-8 version)	Same
Memory Capacity	1024 GB Max for two-card version 4096 GB Max for eight-card version	Same
Supply Voltage and Source	3.1V-5.0V battery voltage 5.0V USB cable (for configuration)	Same
Battery	1 ea. Tadiran TL-5930/F (lithium, 17000mAh) -or- 3 ea. 'AA' alkaline (≈2500mAh)	4 ea. Tadiran TL-5930/F (lithium, 68000mAh total) -or- 12 ea. 'AA' alkaline (≈10000mAh total)
Power Consumption (w/ 32 GB SanDisk Extreme Pro Cards)	0.06mA Standby 4mA acoustic event detection 49mA @ 25 kHz sample rate 51mA @ 100 kHz sample rate 54mA @ 250 kHz sample rate	Same
Battery Endurance and memory requirement at 20° C	10 years standby	10 years standby

(w/ Tadiran TL-5930 / F batteries)	6 months acoustic event detection 12.3 days @ 25Hz/76GB 11.8 days @ 100kHz/291GB 11.1 days @ 250kHz/728GB	24 months acoustic event detection 62.6 days @ 25kHz/304GB 60.2 days @ 100kHz/1164GB 56.8 days @ 250kHz/2912GB
Operating Modes	<ul style="list-style-type: none"> • Continuous Recording • Duty Cycled • Acoustic Event Detection Mission start & end time definition available for all	Same
Dynamic Range	96 dB (16-bit conversion)	Same
Hydrophone	Integrated in exchangeable end-cap. See specifications below.	Same

D. Hydrophone End-Cap Specifications

The microMARS hydrophone end-caps are user-replaceable. The end-caps define the acoustic characteristics (frequency and sensitivity range) of the recorder. The table provides specifications for currently available and anticipated hydrophone end-caps.

Part #	Pre-Amp Gain	Flat frequency response range (3 dB cut-off points)	Roll-off beyond cut-off points (dB / Octave)	Signal range (dB re 1μPa)	Noise floor (dB re 1μPa / $\sqrt{\text{Hz}}$)	Status
MH33-1	18 dB	0.6 - 33 kHz	6 dB	70-166 dB	70 dB	Available

MH33-2	38 dB	6 - 33 kHz	6 dB	50-146 dB	53 dB	Available
MH125-1	40 dB	TBD - 125 kHz	12 dB	TBD	TBD	In Design, High frequency optimized

Appendix

microMARS Power Consumption and Battery Endurance