Sonobuoys

SWFSC CalCurCEAS 2014

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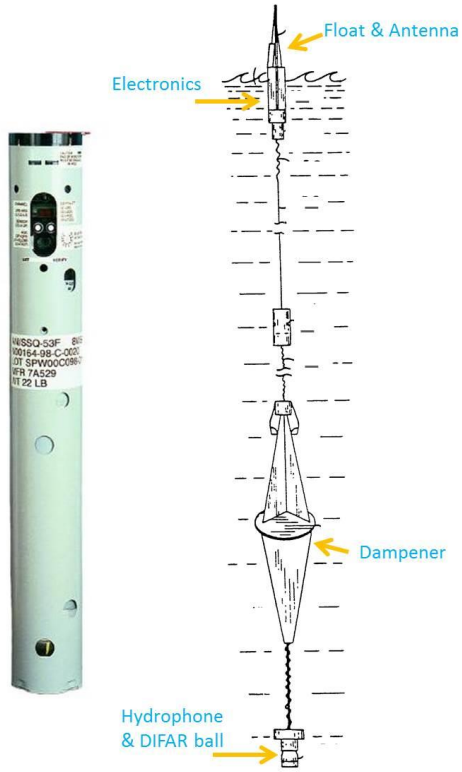
Background Info

1. Sonobuoys

Introduction to Our Friend, the Sonobuoy

Sonobuoys are disposable hydrophone units surplused by the Navy, and we manage to scrounge up a few to be used in certain situations. The beneficial aspect of the sonobuoys is that since they are disposable, we can deploy them near a sighting and then leave the area, so that the recordings are less likely to be masked by ship noise. This is especially important with lower frequency vocalizations, such as those from baleen whales. They are also free, that's a good thing. However, the surplused buoys are usually past their prime, and there is a high failure rate, usually due to dead batteries (which are housed within the sonobuoy unit).



Anatomy of a Sonobuoy

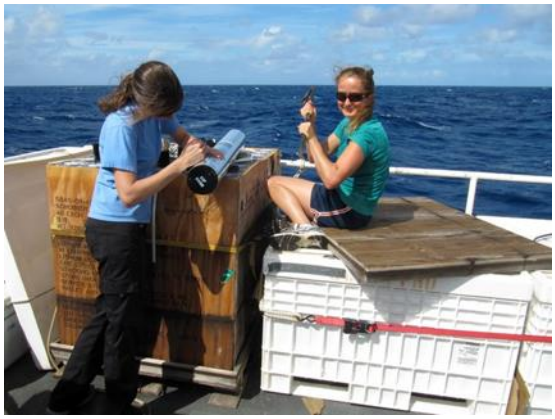
The sonobuoy itself consists of a metal housing, often within a plastic case. Within this housing is a battery, the hydrophone, a float, and an antenna (and some cables). When the buoy is deployed, these separate out and look like the picture (above). The hydrophone hears (duh), sends the info up the wires, and the antenna sends out the information on radio frequency. We then receive this information on the ships antenna on the same radio frequency.

There are several types of sonobuoys, but they all have the same basic parts. During this survey we will be working with 53F or rebuilt (and re-chargeable) 'Don-o-Buoys', developed and constructed by Don Ljungblad.

The 53F sonobuoys have three sensor modes, CSO, CO, and DIFAR. For the most part, we will work with in DIFAR mode to allow for localization of baleen whale vocalizations. If 53F sonobuoys are used on other species, they can be used in CO mode to allow for detection of frequencies up to 20 kHz. Within these DIFAR buoys there is a magnetic compass, and information regarding the direction of the various sounds is relayed up the wires and also sent out on the radio frequency. This "DIFAR" signal is the annoying 7.5 kHz and 15 kHz tonal sound. These buoys are especially important if we need to tell the direction of a vocalizing whale, for example, if we need to positively match a biopsied whale to a vocalization to understand the gender of the vocalizing whale. We can also select the transmission channel (which is the VHF frequency we will send/receive on our Winradio receivers), the Life (how long before the sonobuoy scuttles, or sinks to the bottom of the ocean), the Depth (how deep the hydrophones are deployed to), the Sensor (CSO, CO, or DIFAR), and the AGC Level (Automatic Gain Control: On/Off). The AGC continuously varies the gain according to the current conditions.

Sonobuoy Preparation

You will want to make sure that the sonobuoys are prepped and ready to go before you need them. To make life a little easier, put a tape label on them with the programmed settings. This label can then be transferred to the greenbook to make sure we get that info in correctly (I have tossed buoys and forgotten to see what frequency they were at, that sucks). You will want 4-5 sonobuoys prepped at any given time. The secondary acoustician will be responsible for ensuring that all equipment is prepped and ready to go, and they will also be responsible for all opportunistic sonobuoy deployments.



When you prep the buoy, you want to take it out of the plastic case and cut off any excess garbage. First you will take off the tabs on the lid, then the lid. Take out the buoy and cut off the "L-shaped" plastic doo-hickey and the parachute. To increase the likelihood of the buoys working well, we need to take off the plastic cap on top. Usually you will need to pry off a flat

bar (using a screwdriver) and then break off a plastic bar (good luck). Once that cap is removed, take off any accessory plastic to save a few more fishies, but be careful to not cut the antennae float. The sonobuoys have better success in deployment with the parachutes in place. You will then set the sonobuoy specifications (according to the details in the 'Deployment' section), and then write these settings on a piece of tape over the top of the buoy. This tape can then be removed at deployment and put in the greenbook to ensure you remember the settings!

In addition to having sonobuoys prepped and ready to go—the Sonobuoy Recording station should be ready at all times. In the morning, turn on the rack system, computer, and software programs and make sure they are all ready to go.

2. Don-o-Buoys

We have a set of modified sonobuoys that can be tethered to the vessel to allow for retrieval and recharging of the batteries. These are known as 'Don-o-Buoys' after Don Ljungblad, who built them. These are constructed from several different types of sonobuoys (53D, 53F, 77A) and are all slightly different. Use of these buoys will reduce trash in the ocean and also extend our supply of expendable sonobuoys. If any of the Don-o-buoys ceases functioning, send it back to the lab at the next port call (NOT in anyones luggage!).

Charging the Don-o-Buoy

Don-o-buoys can be charged using a simple 12v charger. The On/Off switch must be set to CHARGE. The positive charger cable will be connected to the screw/nut on the housing labeled "+" and the negative charger cable will be connected to the bar at the bottom of the housing which holds the batteries. When it is finished charging, you can keep this switch in the 'charge' position, as it will be less likely to be turned on accidentally (which will then discharge the battery!).

Bench Testing

All sonobuoys and Don-o-buoys are grounded to the seawater, so when you are bench testing the Don-o-buoys, you MUST ground the "-" position (the bar at the bottom of the housing) to the DIFAR ball.

Deploying Don-o-Buoy

Prior to deployment, set settings on Don-o-Buoy. All settings should be as they are in the typical sonobuoys, with the time of deployment set to the maximum allowed. *Be sure that the Don-o-buoy is retrieved prior to the end of this time—otherwise it may self-destruct!* Next, inflate the float using a bike pump.

The Don-o-buoy will be tethered to the ship, and it should be deployed such that it drifts *away* from the ship (or, the ship drifts away from the Don-o-buoy!). The Don-o-buoys should not be

deployed if the vessel will be moving greater than 1 knot speed. The Don-o-buoy should have a floating polypropelene line attached to it and the end should be tied to the ship. Deploy the hydrophone first, and then the body of the Don-o-buoy. Make sure that the shipboard end of the tether is securely fastened to the ship, and deploy the Don-o-buoy slowly. If the ship looks like it may drift over the Don-o-buoy, quickly retrieve the buoy and reconsider deploying on the opposite side of the ship.

Once the Don-o-buoy is deployed, check the reception and received signals on the Winradio receivers and on the Pamguard Spectrogram display. Retrieve the Don-o-buoy prior to the scuttle time, rinse off with freshwater, and recharge.

If it is an option to deploy the Don-o-buoy from the RHIB during a sighting, this may be an ideal way to obtain an opportunistic sighting. Only do so if you are sure there will be sufficient time to deploy and retrieve the Don-o-buoy. In this case, the Don-o-buoy will be tethered either to the RHIB (if it will remain stationary) or to a float (or man-overboard pole). Request that the flying bridge enter in the location information to aid in retrieval.

Deployment

1. Summary

We have a limited number of sonobuoys and we expect to deploy two sonobuoys per evening station in addition to opportunistic sonobuoys during sightings of baleen whales. We do not have sufficient sonobuoys to do all that we wish to do, so we need to try to conserve sonobuoys by using 1 Don-o-buoy per evening station as well as prioritize deployment of sonobuoys during baleen whale sightings.

All shipboard communications should use handheld radios during sonobuoy deployment, at least for the 1 hour station, but preferably whenever a sonobuoy is deployed and there is not an absolute need for using the mounted radios (which interfere with sonobuoy reception).

Sonobuoy Preparation

Several (4-5) sonobuoys should be prepped, programmed and ready to go at a moments notice. Preparation includes removal of excess plastic housing (see Background Info on Sonobuoys) and setting of specifications.

The settings for the 53F sonobuoys include: Sensor, Depth, Channel, AGC Level. Three of these settings will be standardized and only changed for specific situations; only the channel will vary for most situations. All prepped buoys should have the following settings for:

- Sensor: DIFAR
- AGC Level: OFF

- Depth: 90ft

When choosing a transmitting frequency, there are several factors to take into consideration. First, there are many channels that cannot be used in the EEZ (within two hundred miles) of any country (Ch 1, 5, 12, 17, 19, and 25). Also, each ship has a range of frequencies that are optimal for their antenna system. The CalCurCEAS antenna has a peak reception at 144 MHz (which correspond to channel 53). We would therefore receive signals from this channel over a greater distance. Another factor to take into consideration is if other buoys were tossed nearby. You want to make sure that you receive from a "clean" frequency, with minimal interference. Therefore, if you will be using two sonobuoys in a sighting, or on sightings near each other (w/in 10 nm or so), then you will want to choose transmitting frequencies that differ by at least 2 channels. For your prepped sonobuoys, choose different frequencies over the optimal frequency range (for example, I would have my prepped buoys set to channels 49, 51, 53, 55, and 57).

After the buoy is prepped, label the information on the tape and put it on the lid. Prior to deployment, you will view the settings to make sure they match the settings on the tape, then remove the tape and put it in the greenbook for that deployment.

Deployment of the Sonobuoy

You will want to take a radio with you when you deploy the sonobuoy for communication. Ask the flying bridge when the best time is to throw the buoy (closest approach to the animal, if possible). You will also want to ask permission from the bridge to throw it overboard, and ask the flying bridge to mark the location in WinCruz. Watch the sonobuoy until the antennae pops up, then return to the acoustics lab. If there is a good signal, let the flying bridge know and monitor the sonobuoy. If there is no signal and you suspect that it was a bad sonobuoy, prepare to toss another buoy (and let the flying bridge and bridge know your intentions).

Good Buoy/ Bad Buoy

Maybe the most difficult part to get the swing of is determining if the buoy was good or bad. First, you want to know if the float popped up. It usually happens within 30 seconds, but sometimes this takes up to five minutes. Second, when you get in the lab, check the reception on the receivers. Are all the bars lit to show full reception? If Yes, GOOD! If no, look at troubleshooting. Third, check that you have good reception on the winradio receiver. Do you have a good signal on Pamguard? If Yes, GOOD! If not, see if you need to increase the recording level. If this doesn't help, check troubleshooting. Fourth, check the headphones. Do you hear ship noise? If it is a difar buoy, do you hear the Difar signal (high pitched tone)? If Yes, GOOD! If no, check the troubleshooting again. Finally, check the spectrogram. The first check you will do is with the "sb test" configuration. This will look at all frequencies, so that you can check for ship noise and the Difar signals. With the spectrogram in the "sb test" mode, look to see that there is a lot of low frequency noise (ship noise), and if it is a difar buoy, that you have dark lines at 7.5kHz and at 15kHz. If Yes, GOOD!! If not, then you know where to go from here…..

If your buoy is good, then you are set and you can move on to the monitoring part. If the buoy appears to be bad, then decide if you want to throw another buoy. If it is a very high priority sighting in great conditions, then toss another buoy (make sure it is a different channel!). If it is

so-so conditions, you are low on buoys, or you have left the location or lost the whale, then you may want to blow this one off.

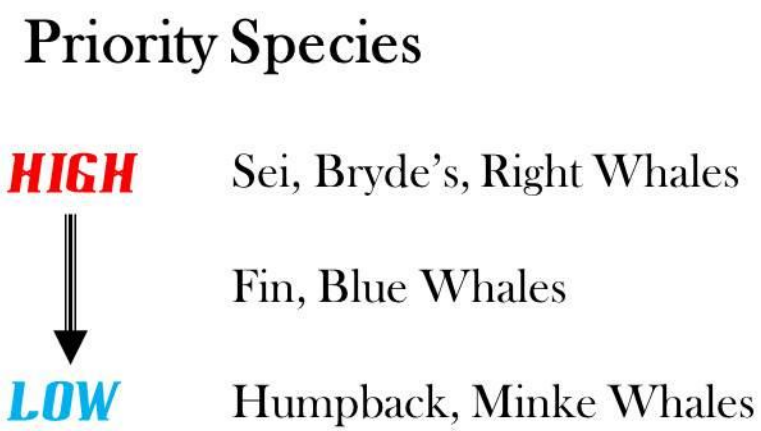
If you do decide to toss a second buoy, it should be a different channel (two channels away from the first buoy), and you will want to initially set each receiver to a different channel. Sometimes you will get the first buoy a little bit later, so you want to be ready. The receivers and DAT can handle two channels total, so you are set.

2. Opportunistic Deployments on Sightings

Opportunistic deployment of sonobuoys on sighted baleen whales provides us with fundamental information on the vocal repertoire and behavior of these species. These provide the foundation for larger studies involving density estimation and stock assessment.

Unfortunately, we do not have sufficient sonobuoys to deploy on all sightings of baleen whales. We have therefore developed priorities for sonobuoy deployment to ensure that we have sufficient sonobuoys for the entire cruise. These priorities may be revisited later in the cruise if there are enough remaining sonobuoys to relax some of the restrictions. If the opportunity arises to deploy a Don-o-buoy (from the RHIB or the vessel will stay on station), then there are no restrictions on deployment.

It is difficult to choose when to toss a sonobuoy, there are conflicting factors involved. You will need to think about the priority of this species, the group size, time available for operations, the number of sonobuoys you have, and how far into the cruise you are.



We will *always* want to deploy sonobuoys on priority species sightings of 1-2 animals that will be approached for biopsy operations if there are no other baleen whale species in the area and the animals are not traveling fast. If the animal is traveling too quickly, both the animal and the ship will leave the area of the sonobuoy rather quickly. If it is a large group of animals, we cannot

use the DIFAR to determine which animal is calling. Deployment of sonobuoys on a large group that is single-species is preferred over a mixed-species group.

Do not deploy a sonobuoy on fast-traveling animals or if we will not approach the animals. Do not deploy on mixed-species schools unless you have sufficient sonobuoys or are able to use a Don-o-buoy.

After you decide "if" you will toss a buoy, then you need to decide when to toss the buoy. If you toss a buoy at the beginning of the "chase", you will have a longer time to record, but there is a good chance that the whale will move away from the sonobuoy and that ship noise will interfere with recordings. However, if you wait too long, you may miss your chance entirely, or you may only have a very brief time to make any recordings at all. With the exception of fast-moving animals, I have generally found that it is better to deploy the buoy at the beginning of the operations. Be sure to give enough time to ensure the species identification and that there will be attempts at biopsy (I find its best to camp out on the flying bridge while making this decision—then you will know what their plan is).

Before you head out to toss the sonobuoy, you will want to double-check the lab equipment and make sure everything is hooked up properly. Request permission to deploy the sonobuoy, and then let her go!

Also, we will want as many resights as possible entered into the computer. Ask the flying bridge observers to enter in as many resights on the animals as they are able to—these will save automatically into Pamguard (on the Array—but these datasets will be merged). Alternatively, write down as much information on location of the ship and whales relative to the sonobuoy as you are able to within the Pamguard comments (on the Sonobuoy computer).

3. Sonobuoy Stations

We will have evening sonobuoy stations for a minimum of 1 hour every evening. These stations will consist of two sonobuoys recorded for a minimum of 1 hour while the ship is stationary. Details of station preferences are outlined below.

1. Station will consist of 1 hour (minimum) of recording, with initiation of the sonobuoy station 1 hour after sunset. Exact station location would be determined by the bridge by sunset.
2. Each station will consist of 2 sonobuoys deployed 1 km from each other. The first sonobuoy would be deployed 1 km from the station while the vessel is in transit to the station. The second sonobuoy would be deployed at the station. If both sonobuoys are expendable (53F), then the vessel will move a minimum of 2 nmi from the sonobuoy. If the second buoy is a Don-o-buoy, then the vessel will remain on station, with the Don-o-Buoy tethered to the vessel.
3. Ideally, the vessel will turn off all engines during the station. If this is not an option, then ideally the vessel will maintain a speed/position that minimizes noise.

4. Recordings will consist of a minimum 1 hour with both sonobuoys deployed.
5. Monitoring will consist of a minimum 1 hour real-time monitoring by an acoustician (aural/visual using spectrogram display) and automated detection using detectors for stereotyped blue, fin, and minke whale calls.
6. Logger forms will be fully completed for each sonobuoy (1 form per sonobuoy). Notes on sonobuoy reception, detection of biological and manmade noise, intereference, etc, will be noted in the Pamguard comments on the sonobuoy computer. At the end of the station, the data will be backed up.
7. The station will end after 1 hour of recording (with 2 buoys in the water) or when sonobuoy reception is lost. Recordings can continue beyond monitoring.

Data

1. Data Collection

Record all channels at 48kHz sample rate. It is helpful to start the recordings prior to deployment (sometimes a buoy will die upon deployment, and this recording can help identify this situation). Record until reception is lost on *all* buoys. Be sure to note which sonobuoy is recorded on which channel. This is absolutely critical.

Logger forms should be completed for EACH sonobuoy. Comments should be made in Pamguard, which allows for a GPS stamp. Any additional information from the observers regarding the animal's location, behavior, or other species/animals in the area is also helpful. Remember that the person analyzing this data will have no idea of the situation in which the recordings were made, so any information is helpful!! Add any information regarding the position of the whale and sonobuoy in relation to each other and in relation to the ship. Note any behavior. Record the reception strength the time when the signal starts to fade.

The whistle and moan detector will be run (in real-time or post-processing) to note detections of all stereotyped calls from blue, fin, and minke whales. The acoustician will aurally/visually monitor the recording for all opportunistic recordings and for a minimum of 1 hour during evening sonobuoy stations. All detection notes will be made in Pamguard comments.

Testing of the DIFAR module in Pamguard may occur if it does not interfere with basic recording and monitoring.

Ideally, the sonobuoys will be preset and ready to go, with a strip of labeled tape on the plastic canister. Pick the best buoy, toss it, and stick the tape in the green book.

2. Data Analysis

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3. Reports

Troubleshooting

1. Sonobuoy

The receivers show reception, but I can't hear the sonobuoy!

- Check the volume for the headphones, is the headphone setting correctly set?
- Check the wires from the receivers into the Fireface, and from the Fireface to the computer and headphones… are they setup correctly?
- Is the Computer recording? Turn up the recording volume on the Fireface. Do you hear anything now?
- Can you hear the DIFAR signal (high pitched annoying tone at 7.5 kHz and 15 kHz)? This is the easiest way to identify a 'good' signal.

Signal fades too quickly.

- How far is the ship from the buoy? Ask if the ship can stay w/in 1nmi of the buoy.

No Reception on Receivers

- Did you put in the correct channel? Slowly scan all the channels and see if you get reception elsewhere.
- Did the sonobuoy pop up? Maybe it was a bad one. Give it 5-15 minutes, ask if anyone saw the float pop up.
- Do the "channels" on the Winradio receivers match the frequencies they are supposed to (check the chart)?

I sometimes hear loud interference

- Does it coincide with radio communication? If so, ask the observers and bridge to minimize radio communication, and ask the bridge to switch to handheld radios, if possible.
- Is the sonobuoy far away? As the signal gets weaker, it takes less and less to "interfere" with the signal. You may need to move closer to the buoy.

Everything was fine for a while, then the sound from the buoy turned to bad noise

- Check the Winradio receivers… are you still getting reception? If no, then there is a good chance your buoy died a sudden death. Still hang out for a while, they have been known to come back from the "dead".
- If you still have what appears to be "good" reception on the receivers, then reset the spectrogram to look at the full frequency range. Do you see the DIFAR signals? Do you see the roll off on the ship noise? Does it look "good" to you????

2. Don-o-buoy

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3. Software

I don't have a visual display on the computer

- Is the wiring hooked up correctly, with all the connections firmly in place?
- Are all the channels of the Winradio receiving good levels of input? If no, increase the recording level as necessary. If yes, then check the output to the computer (headphone jack), do you need to increase the volume?
- Check the computer settings: first look at the full spectrogram (up to 20 kHz) to see if you can see the DIFAR signals, if applicable (7.5 kHz and 15 kHz), and the roll off of the ship noise. If not, then recheck your wiring. If yes, then when you switch back to viewing for vocalizations, recheck your parameters, and maybe increase the volume.
- Give the computer a re-boot if it is acting up. Talk nicely to it.

Sonobuoy Deployment: *the short version*

2. **To Buoy or not to Buoy?** Is it a priority species? Is it a smaller group size? Are the animals traveling fast? Will there be a biopsy? Is there sufficient time for recording? Determine the best location to deploy (beginning of sighting? Closest point of approach?)
3. **Check receiver/recorder connections:** Are all the connections in place? Start the computer spectrogram program. Are the receivers on and tuned to the correct channels? Is Pamguard up and running and ready to go?
4. **Prep Sonobuoy Notes**: Enter in the initial information into the Logger form. Tape the sonobuoy settings into the notes.
5. **Buoy Deployment**: Recheck the settings on the buoy, ask permission to toss the buoy, and throw that bad boy over. Wait to see if the float pops up. Ask the bridge/flying bridge to use hand-held radios and to minimize communication.
6. **Check Buoy**:
    a. Check the receiver: are you getting reception?
    b. Check the recording: do you have a reasonable level? Is it set to 'continuous' recording?
    c. Listen to the recording: do you hear ship noise? Do you hear the DIFAR?
    d. Check the spectrogram: do you see ship noise? Do you see the DIFAR?

At this point, double-check that you are actually recording, and that the "pause" is not on!

7. **Monitor and Notes**:
    a. Run the Pamguard Whistle/Moan autodetector
    b. Change spectrogram to monitor for vocalizations
    c. Monitor aurally/visually, make notes of anything of note (Pamguard comments)
    d. Complete entire Logger form for Sonobuoy
    e. Enter all possible updates on sonobuoy/whale location (Pamguard comments)

8. Death of a Sonobuoy
    a. Is the reception on the receivers dropping to low level?
    b. Is radio communication interfering with reception?
    c. Can you hear static rather than ship noise?
    d. Is there too much static on the spectrogram to see vocalizations?

IF SO, THEN YOUR BUOY IS DYING!!!!

⇒ IF YOU NEED MORE TIME: ask to return to the buoy, stay approx 1nmi away from the buoy for good reception and low ship noise

⇒ IF IT IS NOT WORTH IT: then keep recording for the helluvit, and but go and enjoy the day

53F Specifications

SonobuoyTech Systems

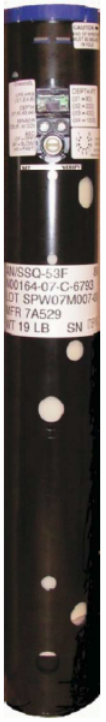
AN/SSQ-53F DIFAR Sonobuoy

Passive Directional

The AN/SSQ-53F is a NATO A-size sonobuoy manufactured for the U.S. Navy which combines a passive directional and calibrated wide band omni capability into a single multi-functional sonobuoy. This advanced sonobuoy combines the capabilities of both the AN/SSQ-53D and AN/SSQ-57 sonobuoys.

The Q-53F can operate in three available acoustic sensor modes that are selectable via EFS or CFS. A Constant Shallow Omni (CSO) provides acoustic information at a fixed depth of 45 ft (13.7 m) while a Calibrated Omni (CO) co-located with a DIFAR sensor provides acoustic information at a selectable operational depth. The buoy amplifies the underwater acoustics and provides directional data necessary to establish bearing to the source of the acoustic energy.

This sonobuoy features both Electronic Function Select (EFS) for use prior to loading and launching, and Command Function Select (CFS) to allow the operator to modify the sonobuoy's mode of operation after it has been deployed in the water. These functions allow the operator to select operating mode (sensor selection), buoy life, depth setting, AGC level and RF channel.



- Acoustic Sensor Selection
  - *CSO, CO, or DIFAR*
- EFS Selectable
  - *RF Channel, Life, Depth, Sensor, AGC level*
- CFS Commandable
  - *RF Channel, Life, Sensor, AGC Level*
- 1 Watt 96-channel RF transmitter
- Factory configurable to AN/SSQ-53D standard
  - *Single Sensor (DIFAR)*
  - *3 Depths (90 ft, 400 ft, 1000 ft)*
  - *No CFS*

Sonobuoy Tech Systems supplies U.S.-specified sonobuoy products and support to the international market.
Phone: 260.248.3503 • Fax: 260.248.3510 • Website: www.sonobuoytechsystems.com

SonobuoyTech Systems

SPECIFICATIONS

NSN 5845-01-475-9870

PHYSICAL CHARACTERISTICS

Weight	8.6 kg (19 lbs)
Sonobuoy Launch Container	LAU-126/A

PERFORMANCE DATA

RF Command Receiver	UHF – single channel
RF Transmitter Power Output	1 W minimum
RF Transmitter Operating Frequency	96 Channel Selectable (136.000 to 173.500 MHz)
Sensors/Audio Frequencies	CSO (30 to 5000 Hz) CO (5 to 20 kHz) DIFAR (5 to 2400 Hz)
Operating Life	0.5, 1.0, 2.0, 4.0, or 8.0 hours
Operating Depth	d1: 27 meters (90 ft) d2: 61 meters (200 ft) d3: 122 meters (400 ft) d4: 305 meters (1000 ft)
EFS selections	RF, Life, Depth, Sensor, and AGC
CFS selections	RF, Life, Sensor, and AGC
Launch Altitude	12 to 9144 meters (40 to 30000 ft)
Launch Speed	0 to 370 KIAS
Shelf Life	5 years in sealed container

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Columbia City, IN 46725

Sparton Electronics
Government Business Systems
5612 Johnson Lake Road
Deleon Springs, FL 32130

Sonobuoy Tech Systems, is a joint venture between Undersea Sensor Systems Incorporated and Sparton Electronics Florida, Inc.