VSW BUOY
OPERATOR MANUAL

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Presently, the document should be used in reference with Micromodem-2 User's Guide.

Contents

OVERVIEW

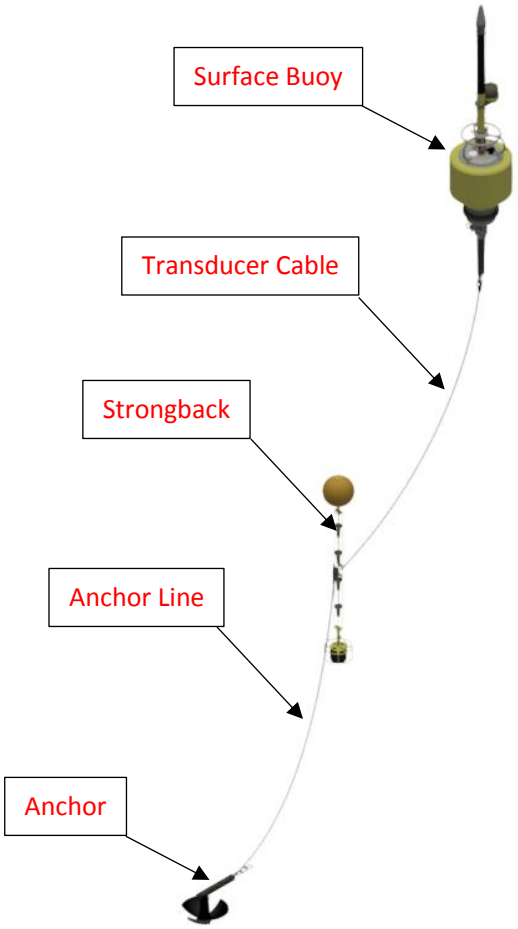
This Manual is intended to be used as a guide in packing, unpacking, and field preparations to deploy a Gen 3 VSW Buoy developed by the Acoustic Communications Group at Woods Hole Oceanographic Institution. For operation of a Micromodem 2 system please refer to the Micromodem2-Users-Guide located on the Acoustic Communications Group website: https://acomms.whoi.edu/micro-modem/software-interface/

Major Components

There are three major components of a VSW Buoy:

- Buoy – The buoy component sits at the surface of the water which contains all major electronics and communication systems. This includes the Micromodem, Controller board, RF radios installed, and batteries.
- Strongback – The strongback component sits subsurface approximately mid water column. This component contains the acoustic transducer (10kHz and/or 25kHz typically), as well as an optional multichannel hydrophone array. The strongback connects to the buoy via a Kevlar reinforced strength member transducer cable.
- Anchor – the anchoring component contains the mooring anchor as well as chain and mooring line to hold the buoy in position. The anchor portion is fastened to the cage of the strongback.

Figure 1 VSW Buoy System



Configurations:

Several configurations are available for the VSW Buoy system. These configurations include acoustic frequency and RX capabilities, RF radio connections, and Battery/charger configurations. Standard configurations include the option for 25ft, 50ft, and 100ft transducer cable lengths. Proper cable length should be equivalent to the full water depth the moored buoy is to be deployed in. this gives approximately 2x the scope on the drifting buoy to the strongback that is deployed mid water column. The anchor line comes standard at 50ft and can be shortened using the daisy chain technique.

Modem Configurations:

MM01: Single or Dual, Single-RX PSK Micromodem

- Single or dual modem for multiple frequency bands
- Single channel RX
- Configured to utilize one band during deployment
- Manual predeployment configuration required

MM02: Single or Dual, Multi-RX PSK Micromodem

- Single or Dual modem for multiple frequency bands
- Multichannel array RX
- Configured to utilize one band during deployment
- Manual predeployment configuration required

MM03: Dual Simultaneous Multi-RX PSK Micromodems

- Dual modem for multiple frequency bands
- Multichannel array RX
- Configured to use 2 frequency bands simultaneously during deployment
- No manual predeployment configuration required

RF configurations:

RF01: WHOI Iridium/GPS, Freewave (standard)

- WHOI 205102 9523 Iridium
- WHOI 205102 Ublox L1 GPS
- Freewave FGR2 900MHz
- Full endcap LED Functionality

RF02: NAL Iridium, WHOI GPS, Freewave

- NAL A3LA-XM Iridium
- WHOI205102 Ublox L1 GPS
- Freewave FGR2 900MHz
- Iridium endcap status LED functionality not available

RF03: NAL Iridium, Novatel GPS, Freewave

- NAL A3LA-XM Iridium
- NOVATEL OEM615 GPS
- Freewave FGR2 900MHz
- Iridium endcap status LED functionality not available

Battery Configurations:

BC01: Inspired Energy NH2054HD34 Li-Ion rechargeable 98Wh/battery (980Wh System)

- (10) Batteries per buoy
- Non-restricted CLASS 9 batteries contained in equipment
- Be sure to follow all proper Hazmat related shipping procedures when shipping this system
- Failure to ship properly can result in very large fines

BC02: Ultralife UBI-2590U Li-Ion rechargeable 255Wh/battery (765Wh System)

If using BC02 configuration Batteries are Ultralife UBI-2590U Li-Ion Rechargeable

- (3) Batteries per buoy
- RESTRICTED CLASS 9 Hazmat Batteries contained in equipment
- Be sure to follow all proper Hazmat related shipping procedures when shipping this system
- Do not ship on passenger aircraft
- Failure to ship properly can result in very large fines

Optional Accessories:

- Buoy Cart

Box Contents:

Standard buoy's ship in a 52x28x22 Hardigg shipping box with an approximate shipping weight of 200lbs.

Figure 2 Standard VSW buoy Shipping Box

The buoy box should contain the following:

- Fully Assembled Buoy
- Antenna Assembly
- Freewave RF Radio Base Station
- Console/Charging Cable
- Charging Power Supply 24VDC

Unpacking:

- Remove antenna assembly from lid and set aside
- Remove the bag containing the Freewave base station and accessories and set aside
- Remove the hull from the box and place on the cart
- Layout Rigging on ground
    - Anchor
    - Chain
    - Line to Strongback
    - Strongback
    - Transducer Cable to Buoy
- Install transducer cage on the strongback using the (2) ¼”-20 socket head cap screws stored on the end of the strongback

Figure 3 VSW Buoy unpacked with rigging laid out

Once all the rigging is laid out and there are no entanglements in the rigging (Figure 3), the buoys can be packed onto the carts for easy storage.

- Anchor sits on the lower plate with chain coiled around the stem of anchor.
- Line coil is laid on top of anchor.
- Transducer stick is stored vertically behind one of the rubber straps.
- Cable coil is stored in second slot behind the rubber strap.

Figure 4 VSW Buoy Stored on Cart

Antenna Installation:

To install the antenna into the buoy, the locking mechanisms must be opened. There are two thumb screws on the handle assembly that must be loosened as seen in Figure 5. Once the thumb screw on the locking ring is loosened, the ring halves must be opened.

Figure 5 Buoy Hull ready to install Antenna

- Insert the antenna with rotational locking hole aligned with the locking screw as seen in Figure 5. The locking sleeve should easily slide into the handle assembly.

Figure 6 Antenna Aligned with rotational locking screw

- Insert the rotational locking screw into mast by tightening the thumb screw. The screw should fully insert to the shoulder of the thumb screw. If resistance is encountered ensure that the screw is aligned to the hole on both the locking sleeve and the mast.

Figure 7 Insert rotational locking screw

- Close the locking ring and tighten the thumb screw locking the mast in place.

Figure 8 Close and tighten thumb screw to lock mast in place

- Ensure O-Ring is clean Lubricated and installed onto quad coax bulkhead on endcap.
- Align and tighten the quad coax cable to the endcap. This is a positive locking connector and will only thread when properly aligned. Ensure that locking sleeve is completely tightened to the bulkhead. NOTE: IF LOCKING SLEEVE IS NOT FULLY TIGHTENED WATER CAN PROTRUDE INTO RF CONNECTOR DEEMING IT INOPERABLE

Figure 9 Fully installed Quad RF connector

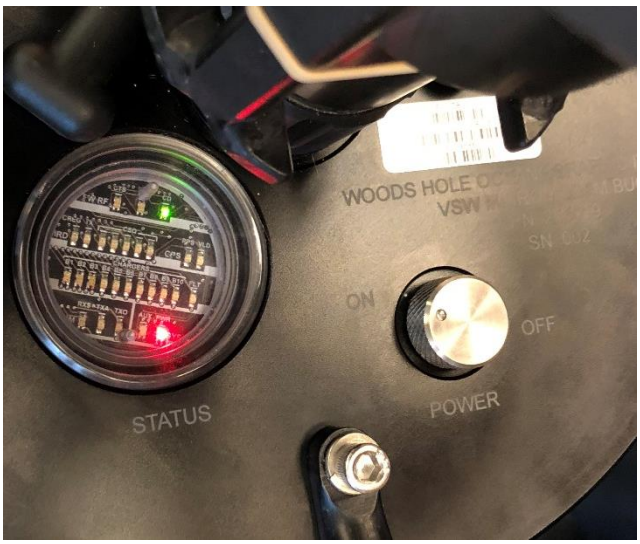
Buoy Operation:

Operating the VSW Buoy can be done using any one of the multiple modes of connection, through the console cable (ideal for bench testing), Freewave, WIFI, or Iridium. The VSW Buoy is equipped with a status LED viewport to indicate the status of the multiple systems internal to the buoy.

Powering the Buoy:

- Turn the switch located on the endcap such that the indicator dot is closest to the ON position. (there are 4 detents in the rotation of the switch such that there should be positive confirmation that it is properly located) once power is properly applied there will be a LED that illuminates to indicate power is on.

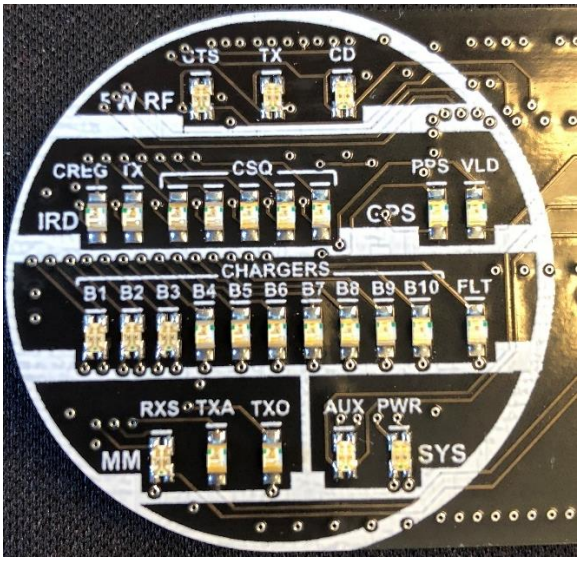
Figure 10 Proper switch position with Power LED Illuminated



Status LED's:

There are several status LED's located on the endcap. These include statuses for system power, battery charge state, freewave connectivity, iridium satellite connection stats, valid GPS, PPS, and Micromodem TX/RX.

Figure 11 Status LED's



- FW RF (for point to point operation)
  - CTS: Freewave CTS
  - TX: Freewave Transmit Active
    - Blinks whenever serial traffic is being passed through radio
  - CD: Freewave Carrier Detect
    - Typical point to point Freewave operation sets CD to solid green when a good RF link is established
  - Refer to Freewave manual for further details on LED operation
- IRD
  - CREG: Illuminates red when Iridium 9523 registers with network
  - TX: blinks whenever modem is transmitting to satellite
  - CSQ: Each green LED indicates a level of signal quality (1-5) where one is lowest and five is best quality signal
- GPS
  - PPS: Blinks blue when the 205102 Iridium Controller board sets a PPS pulse
  - VLD: Illuminates red to indicate the buoy has a valid GPS signal
- Chargers
  - B1-B3 blink green when batteries are actively charging illuminate red if there is a fault (BC02 battery configuration)
  - B1-10 blink green when batteries are actively charging (BC01 configuration)
  - FLT: indicates a FAULT has occurred

- MM (Micromodem)
    - RXS: Illuminates yellow when the Micromodem is expecting to receive a packet (uplink case), illuminates green when a packet has been received and is decoding
    - TXA: Illuminates green when the Micromodem is in an active transmit state
    - TXO: Illuminates blue when the Micromodem is sending a packet through the water (distribution board measures current out of the Micromodem to determine sound is in the water)
- SYS
    - AUX: configurable LED for user
    - PWR: Green when buoy is powered on, Red when system detects batteries are low

Console Cable Connection:

Each buoy is supplied with a console/charge cable. The typical configuration of the RS232 console com port is (115200, N, 8, 1). Typical configurations have the console port on SW2 of the 205118 Edison Controller Board.

- Remove the 8pin male dummy plug from the Console wet connector on the endcap (be sure to remove the locking strap from the back of the connector as seen in Figure 12

Figure 12 Console cable with locking strap removed (partially installed)

- Install the console cable as shown in Figure 12 be sure to fully install the cable until there is no gap between the bulkhead connector and the cable as seen in Figure 13

Figure 13 Fully installed console connector with locking strap installed

Freewave Radio

The VSW Buoy is equipped with a Freewave RF radio. The freewave radio is a line of sight radio system which acts as a console pass through when in Point to Point mode (Typical application). For operation of the Freewave radio system refer to the Freewave Manual (available online).

- Base station set up and configuration
  - Connect a cable and antenna to the Freewave base station.
  - Plug in the power supply for the Freewave base station.
  - The CD LED will illuminate green if a connection is made to the buoy
  - Configure serial port to 115200, N, 8, 1
  - Freewave radio connects to MAX2 on 205118 Edison Controller Board

Buoy Core Removal:

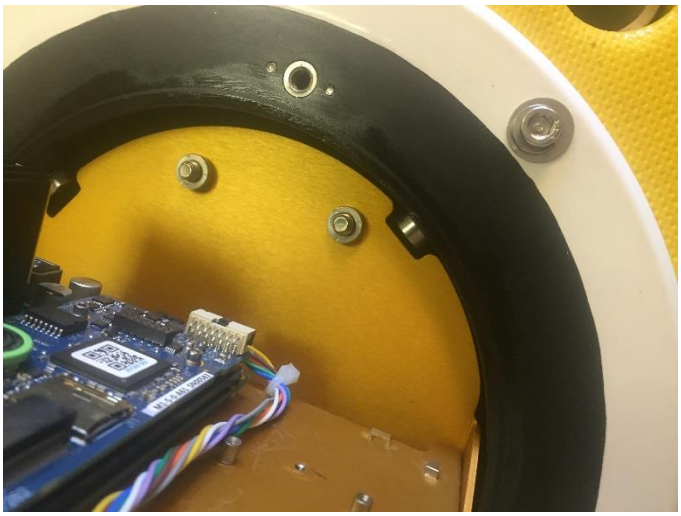
Opening the core of the buoy reveals the internal chassis which houses the buoy electronics and batteries. The buoy endcap is secured to the housing using a twist lock mechanism and secured with a locking pin. Care should be taken to protect the black surface of the buoy hull as this acts as an O-ring sealing surface.

- Loosen the thumbscrew located on the cable lock

Figure 14 Cable lock and thumbscrew

- Lift thumbscrew straight up out of the hole in endcap while holding the cable lock down to the endcap. (this prevents the cable lock from binding on the endcap) Once the thumbscrew is free of endcap lift the cable lock to the handle
- While holding the float stationary (easiest with a second person holding float) twist the handle counterclockwise (as noted on endcap) to the hard stop
- Carefully pull the core straight from the hull (be sure to watch that wiring and electronics do not catch on the twist lock rollers) be sure that rollers are aligned with the slots in the base plate of chassis as seen in Figure 15

Figure 15 Proper alignment to remove core from hull



For details regarding the internal wiring and configuration of the buoy please refer to the system schematic 255019-SCH.

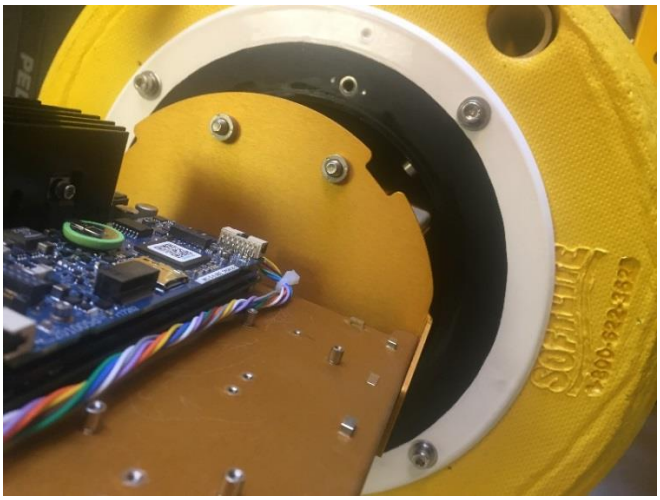
Buoy Core Installation:

When installing the core into the hull special care must be taken that no wires get caught on the twist lock rollers and that the O-rings are cleaned and seated properly. To clean the O-ring surfaces, use a lint free wipe and denatured alcohol to be sure the surface is free of any debris and contaminants. Lubricate the O-ring using a marginal amount of Dow Corning DC-4 Electrical insulating compound. There should be enough lube to make the surface shiny but not so much that it is globed. See Figure 16 below.

Figure 16 Proper O-ring seating and Lubrication

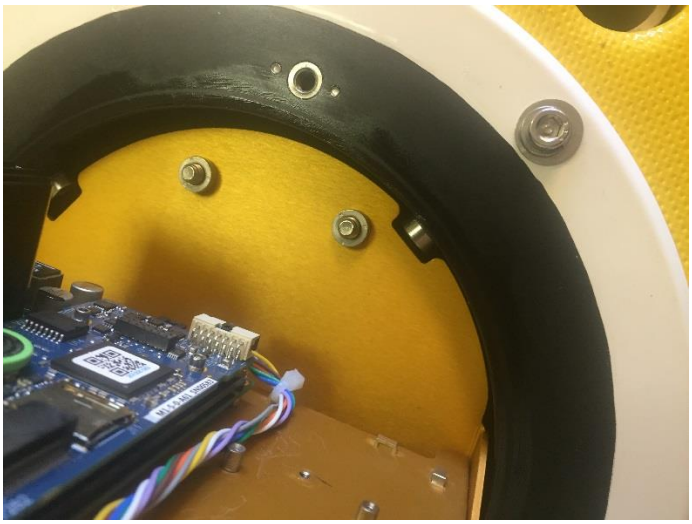
- Insert core into Hull, be sure to align the endcap such that the locking thumb screw is aligned with the alignment mark on the hull. The core cannot be fully rotated within the housing once it is installed.

Figure 17 Buoy core alignment into hull



- Align the slots in the base plate with the rollers. DO NOT FORCE THE CORE INTO THE HULL!
- Continue inserting the core into the hull being sure to keep wires from catching on any of the rollers

Figure 18 Proper baseplate alignment with rollers



- Align track rollers with the locking plates in the endcap, be sure that no cables are pinched between the endcap and hull
- Once the endcap is properly aligned press the endcap into the hull to seat the O-rings
- Twist the endcap clockwise until the hard stop is reached, the locking screw on the cable clamp should be aligned with the mark in the hull

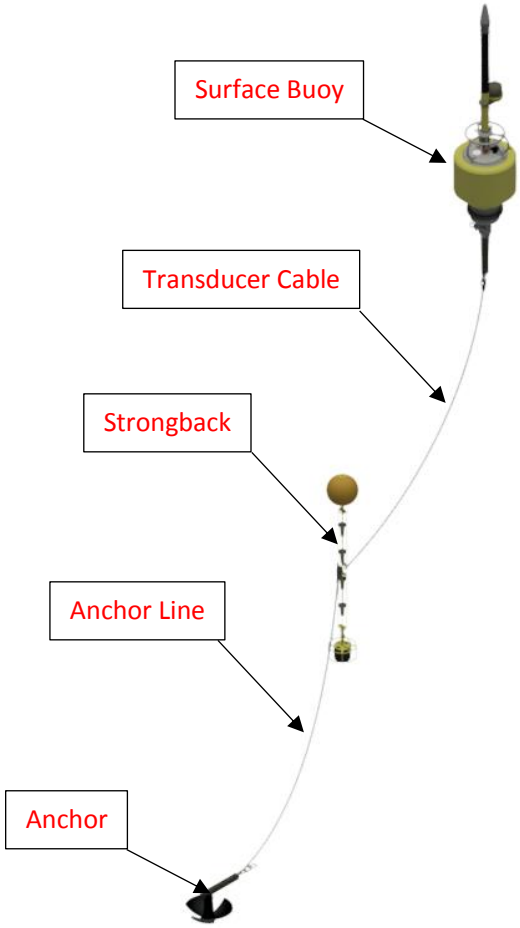
Figure 19 endcap is properly seated and twist lock is aligned and locked

- Properly mate all wet connectors with locking straps
- Tighten twist lock thumb screw until cable lock is tight to endcap

Buoy Rigging:

Proper rigging is essential to successful deployments of a VSW buoy. Special care must be taken to ensure that service loops are present and loads are properly distributed. VSW Buoy components are connected using three styles of connections, shackles, knots, and Yale grips. Each of these connections must be properly executed and secured to ensure proper function of the VSW buoy.

Figure 20 VSW Buoy Rigging Overview



Surface Buoy to Transducer Cable:

It is important to follow the proper sequence when mating the transducer cable to the Surface Buoy. Failure to do so can cause excess strain or damage to the transducer cable.

- cable is mated to the hull using the cable clamp as shown.
    - Note the service loop at the base of the hull
    - Cable clamp is secured using (2) ¼”-20 captive socket head cap screws

Figure 21 Proper installation of transducer cable to hull

- Cable is taped to Tygon tubing using super88 electrical tape every 2ft with small service loops preventing cable strain

Figure 22 Proper mating of cable to surface buoy

- Connecting the surface buoy to the transducer cable is done using a 7/16 YaleGrip secured to a 3/8” galvanized steel screw pin shackle through the base chain link. Note the large service loop at the shackle connection.
    - For proper installation of YaleGrip see instructions on YaleGrip website
    - Secure screw pin shackle using proper seizing wire or cable tie. Tape over the seizing wire to prevent damage to cable.

Figure 23 proper mating of YaleGrip to transducer cable and buoy chain

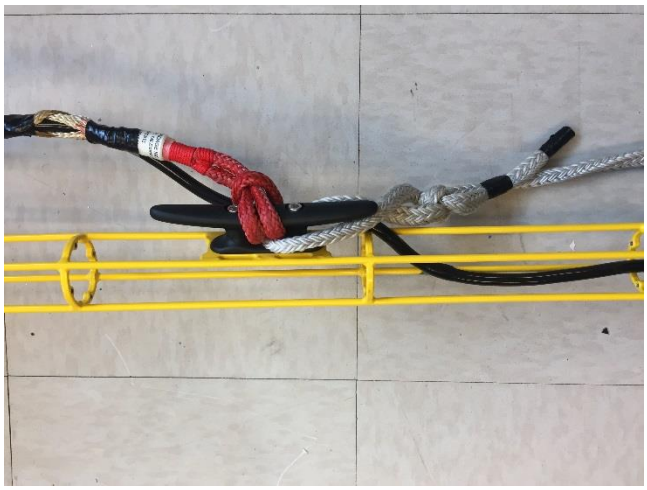
Figure 24 Properly secured screw pin shackle using cable tie

Strongback:

Proper rigging of the strongback utilizes both the YaleGrip as described above and a simple bowline knot. It is important for proper buoy operation that the strongback be rigged in this manner. This allows the strongback to pivot and remain vertical in the water column optimizing acoustic performance.

- The transducer cable is secured to the strongback utilizing a YaleGrip which is looped through the eye of the cleat on the strongback
    - Be sure to include a large service loop in the transducer cable at the cleat to prevent excess strain on the cable
- The anchor line is secured by tying a bowline knot through the eye of the cleat on the strongback

Figure 25 Proper transducer cable and anchor line connections at the strongback



- When mating the transducer cable down the strongback be sure to tape the cable to one of the support rails every 6 inches. The transducer cable should be mated securely to the strain relief on the transducer cage.

Figure 26 Properly mated 25KHz transducer and transducer cable

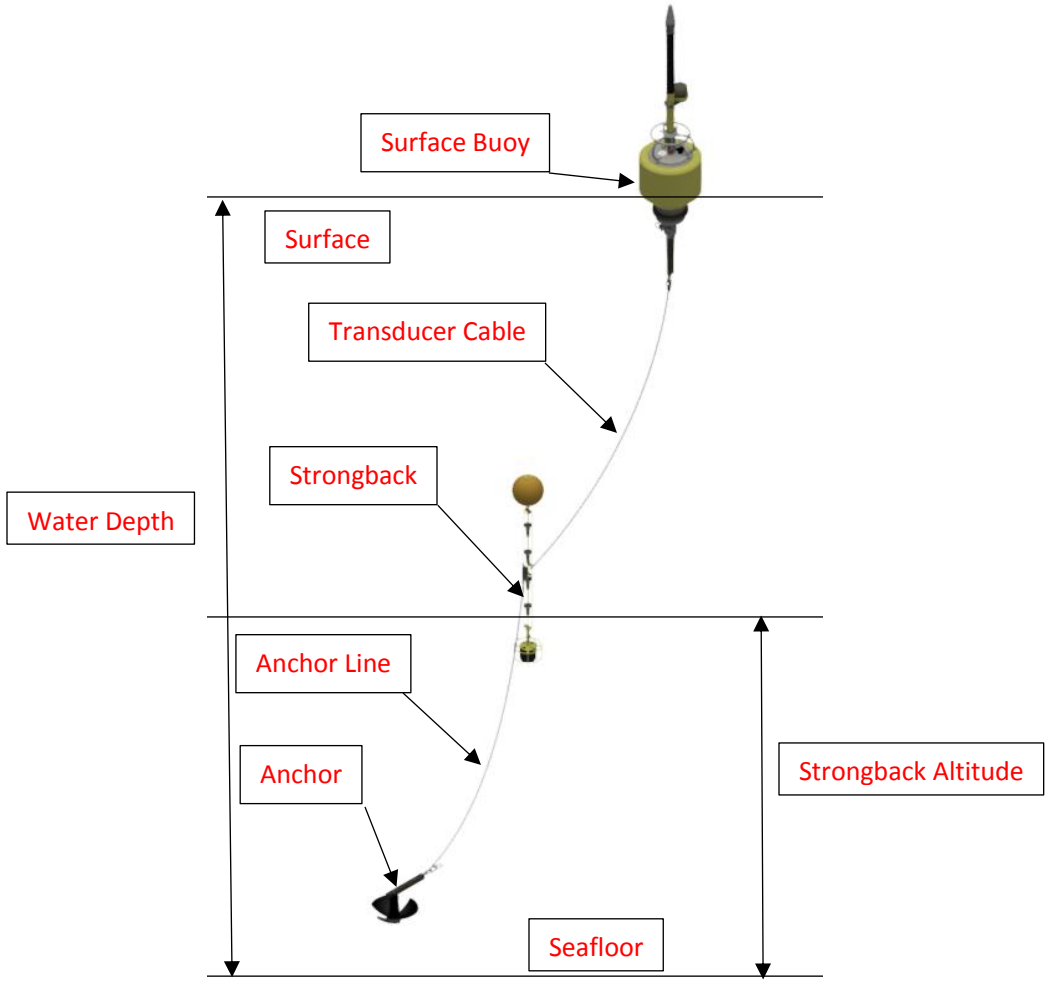
Anchor:

The supplied 30lb anchor is secured to the anchor line using a 3/8 galvanized steel screw pin shackle.

- Shackle is secured through the thimble on the end of the anchor line and through the base link of the anchor chain.
    - Secure screw pin shackle using proper seizing wire or cable tie. Tape over the seizing wire to prevent damage to anchor line.

Buoy Deployment and Recovery:

Properly deploying the VSW Modem Buoy is key to mission success. Proper buoy deployment takes careful planning and predeployment checks. Failure to follow these guidelines can cause total failure of the VSW Buoy System.



Rigging Preparation:

- It is important to inspect all parts of the buoy prior to deployment for any wear or damage. Do not deploy the buoy if components are excessively worn or damaged.
- It is required to properly set the length of the anchor line prior to each deployment
    - Anchor line should be equal to the desired altitude (distance off seafloor) of the center of the strongback, when deployed the strongback with float at that altitude
    - When selecting the altitude, it is important to know that you are limited by the length of transducer cable to the surface. It is important to have a minimum of 1.5x the transducer cable length as distance from the surface to the center of the strongback at max high tide.
    - The anchor line length can be shortened using a daisy chain technique

Deployment:

It is important that the VSW Modem Buoy be properly inspected, prepared and tested prior to deploying in the field. When deploying the buoy, it is important that the rigging is laid out and inspected for any twist or entanglements prior to putting any parts over the side. It is important to follow the deployment sequence below to minimize the risk of buoy loss or damage.

- Before Deployment
    - Ensure that all wet connections are properly mated and the buoy endcap is sealed and locked properly
    - Be sure buoy is powered on and RF communications are working properly
- Anchor over the side
- Hand over hand anchor line into the water
    - Be sure to watch the line for any excessive rubbing on the gunwale or transom
- Deploy the strongback
    - When deploying the strongback be sure that there are no twists or entanglements between the anchor line and transducer cable. The anchor line should be free to run straight down to the anchor from the cleat and the transducer cable free to run vertically to the surface buoy.
- Hand over hand transducer cable
    - Be sure to watch the cable for any excessive rubbing on the gunwale or transom
- Deploy buoy
    - DO NOT RELEASE BUOY UNTIL IT IS CONFIRMED THAT THE ANCHOR IS ON THE SEAFLOOR. FAILURE TO DO SO CAN RESULT IN SUBMERSION OF THE BUOY OR CAUSE THE BUOY TO DRIFT UNCONTROLLED.
    - Gently lower the buoy into the water using a slip line
    - DO NOT USE THE ANTENNA MAST TO DEPLOY THE BUOY THIS WILL RESULT IN DAMAGE TO THE ANTENNA AND FAILURE OF THE RF LINK RESULTING IN POSSIBLE LOSS OF THE SYSTEM

Recovery:

- Surface Buoy
    - using a snap hook or boat hook bring the buoy to the side of the vessel
    - USING THE HANDLE pull the buoy up on deck being careful not to damage the antenna mast
    - DO NOT USE THE ANTENNA MAST TO RECOVER THE BUOY THIS WILL RESULT IN DAMAGE TO THE ANTENNA
- Hand over hand transducer cable
    - Be sure to watch the cable for any excessive rubbing on the gunwale or transom
- Recover the strongback and secure on deck
- Recover the anchor line
    - Be sure to watch the line for any excessive rubbing on the gunwale or transom
- Recover the anchor