Basic Single Beam Setup

by Josh Sampey

Many HYPACK® users' first exposure to the world of hydrographic survey is through single beam survey. Equipment for single beam surveys can be acquired for a reasonable cost, are easily set up on any vessel, and less knowledge is required to attain good data compared to other survey types. This does not mean there are no pitfalls to be aware of when setting up and surveying with a single beam echosounder. Hopefully this article will help you obtain the best data possible from your single beam setup.

Equipment

There are five pieces of mandatory equipment needed to conduct a successful single beam survey:

1) Echosounder
2) GNSS receiver and antennas
3) Sound velocity profiler
4) Mount
5) Computer with HYPACK®

Echosounders

There is an extensive number of manufacturers of single beam sonars and many of these will work with HYPACK®. The most basic echosounder will output only a NMEA DBT record. This is an ASCII data string that only contains the depth calculated by the sonar. These systems are usually very inexpensive and can produce adequate data but there are limitations.

A full survey grade single beam will be able to output an echogram (a visual representation of sound waves reflected from underwater objects). If you have ever looked at a fish finder with a graphic display, that is an echogram. Having an echogram with your data allows you to digitize the bottom of the body of water should the echosounder not properly digitize the bottom due to bubbles, aquatic vegetation, and/or a host of other issues.

Other things to consider when selecting the sonar are the frequency and the beam angle. The frequency will impact the sonar's range and penetration into the bottom, with lower frequencies traveling farther and penetrating more into the bottom than higher frequencies, however with lower range resolution. Meanwhile, the beam angle of the sonar will impact positional accuracy. You can think of the beam shape of a sonar as a cone. A larger beam angle makes a large cone with the base covering a large patch of seafloor with every ping, while a narrow beam makes a small cone with the base covering a small patch of seafloor. Regardless of beam angle, the sounding position is always at

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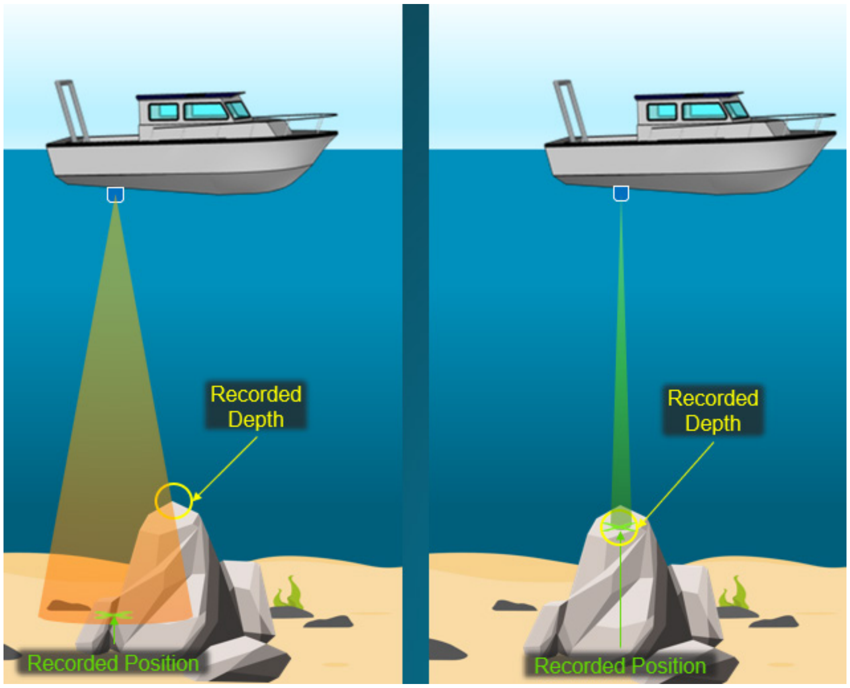
the center of the beam. This can become a problem with large beam angle systems: If a large rock is detected at the edge of the beam footprint, it will be mispositioned to the center of the beam. Depending on water depth, the positional offset can be rather large. Lower frequencies typically have larger beam angles than higher frequencies, however they can penetrate through fluid mud should your survey requirements dictate that need. Many users use a dual frequency system to resolve both of these issues as well as assessing fluid mud thickness.



GNSS Receiver

There is a wide range of GNSS receivers at various price points. For single beam surveys, there are a few things to consider when looking for a GNSS receiver.

1) Is RTK a supported and licensed feature on the unit
2) Can the system support output rates of 10Hz or more
3) Is the GNSS unit dual antenna for heading or single antenna without heading.

Number 3 will be important when considering how you will mount the sonar. This will be discussed in the Offsets section.

Sound Velocity Profiler

A sound velocity profiler is a device that is lowered through the water column and records the speed of sound at various depths. The speed of sound at various depths is then applied to your soundings to accurately calculate a depth.

There are two kinds of profilers, time of flight and conductivity/temperature/depth (CTD). A time of flight sensor usually only has a pressure sensor and a sound speed sensor consisting of a small transducer that pings a known distance, thereby giving speed of sound. A CTD profiler will measure the water parameters of conductivity (also known as salinity), temperature, and depth. These three parameters are then applied to calculate a sound speed using well defined equations.

Both systems will return nearly the same results, however if you need to collect any water quality information for your projects, a CTD may be a better option.

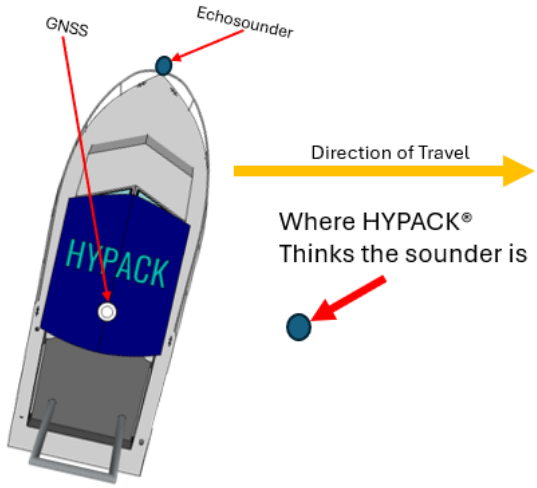
For more information on how sound speed profiles are applied and used for single beam data processing, refer to the article Single Beam Sound Velocity Correction by Joe Burnett.

NOTE: It is very important that you know the speed of sound that was entered into the echosounder at the time of survey. This value is needed in the Single Beam Editor (SBMAX64) to properly apply the sound velocity profiles.

Offsets

Horizontal Offsets

If you are using a single GNSS antenna, then the ONLY acceptable mounting option is to have the GNSS antenna mounted directly above the transducer. A single GNSS antenna cannot provide vessel heading. Without knowing the vessel heading, HYPACK® cannot properly apply horizontal offsets, and your soundings will be incorrectly positioned as HYPACK® will determine the location of the echosounder using course over ground instead of vessel heading.



To understand why, think about doing cross sections on a river. The course over ground will be from one side to the other, but the vessel heading will be pointed upstream. If you have a forward horizontal offset of 3m for the echosounder, HYPACK® will think the vessel is pointing across the river and your sounding will be positioned 3m forward of the direction of travel.

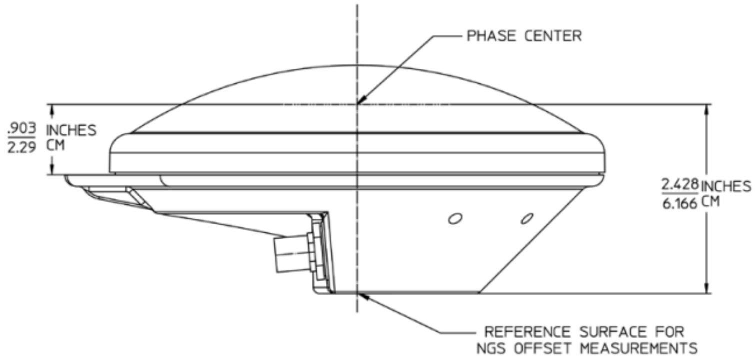
If you are not able to mount the GNSS directly above the sonar then you will NEED to have a dual antenna GNSS system that will be able to provide the vessel heading. This will allow HYPACK® to properly position the devices. Offsets will be based on the primary antenna if using a dual antenna system.

Vertical Offsets

Before measuring your vertical offsets, there are a few things that you will need to find out about your GNSS unit.

1) If you are using an integrated antenna such as a Trimble R12 or a Reach RS2, you will need to know where the position data is being output to. In some receivers, users can select to output the position at the antenna phase center, antenna reference point, or in the case of a Trimble, bottom of quick disconnect. This will determine where you measure to.

2) If you are using a receiver with a separated antenna and receiver such as a Trimble R750 or BD992, you will need to find the distance from the antenna reference point (ARP) (usually the bottom of the antenna) to the antenna phase center (APC). We will measure to the ARP and add the separation between ARP and APC to our measured value. In many cases this value can be found on a sticker affixed to the bottom of the GNSS antenna.



3) Once you have the answer to where your positions are originating from, it's time to measure the vertical component of your offsets. Assuming that your GNSS system is outputting data to the antenna phase center (APC), then the total height you measure and note will be from the APC to the face of the transducer. If your system is outputting data to a different location, i.e bottom of quick connect, then you will measure to that location instead. This will determine the total height of the system. The next part will involve how we handle this measurement.

4) The last measurement we need is sonar draft. If using RTK/PPK this is optional, however it is advised for

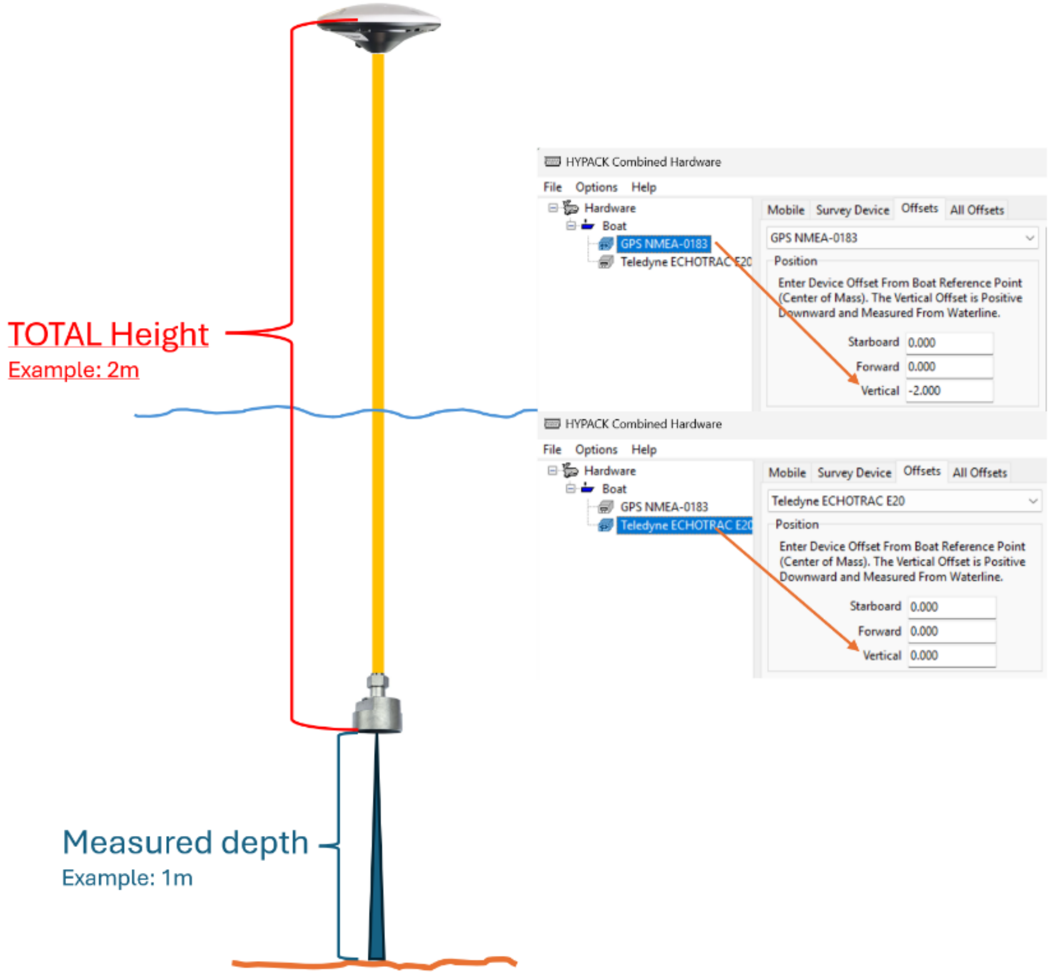
proper sound speed profile application in data editing. This will be a measurement from the water surface to the transducer face. When taking this measurement, try to level the boat at the level it will normally be sitting in the water during survey. This may mean having individuals sitting on the boat as they would during the survey and having another person measure the sonar draft from the dock. This will prevent an erroneous measurement if the boat is listing more with everyone on one side of the vessel.

Entering Vertical Offsets

There are three different ways of handling the vertical offsets that you have measured. Method one will REQUIRE that you use RTK during acquisition or PPK during data processing. Methods two and three will require you to also measure the sonar draft and will only vary in how we apply that measurement.

Method One

If you are using RTK or PPK and you do NOT need to track the water level, then we can treat the system like you would a standard topographic survey rod where the GNSS antenna is at the top and there is a fixed offset to the ground/bottom of the rod. The measured height will be entered into the GPS driver as a NEGATIVE value (HYPACK® uses negative up orientation). In this method, the water surface can be treated much like your hand on a survey rod. No matter where you place your hand, or in this case the water surface, the final elevation will always be the same. If you choose this method, then you will ONLY put the total vertical measurement in the GPS-NMEA driver. This will return a proper elevation, however it will have some limitations if you intend to apply a sound speed profile since HYPACK® will assume that the transducer is at the water's surface, effectively shifting the profile up.



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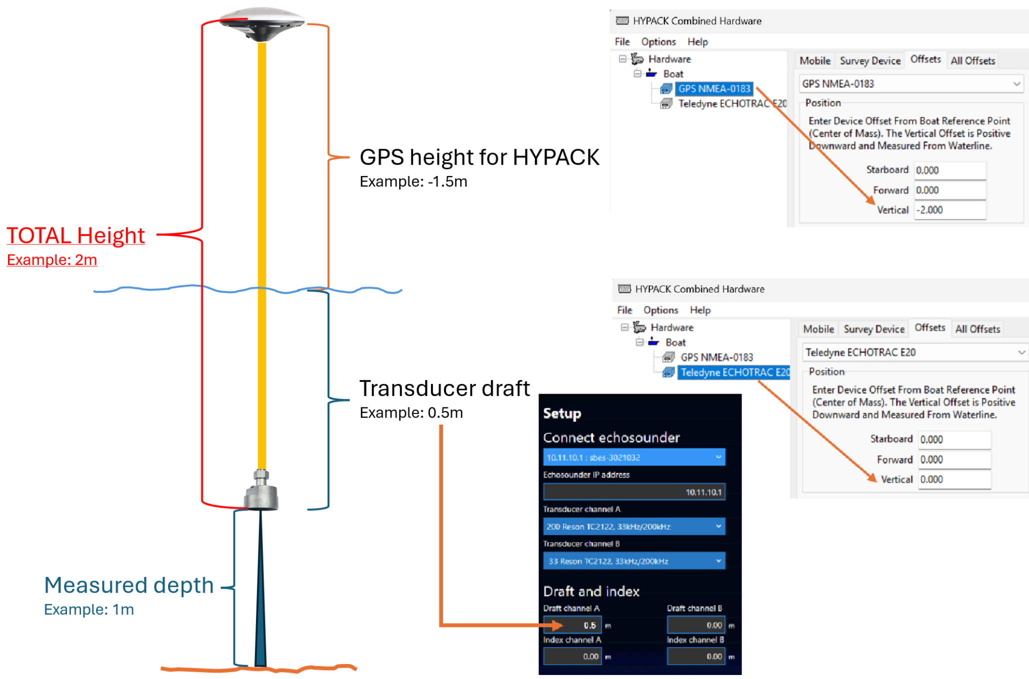
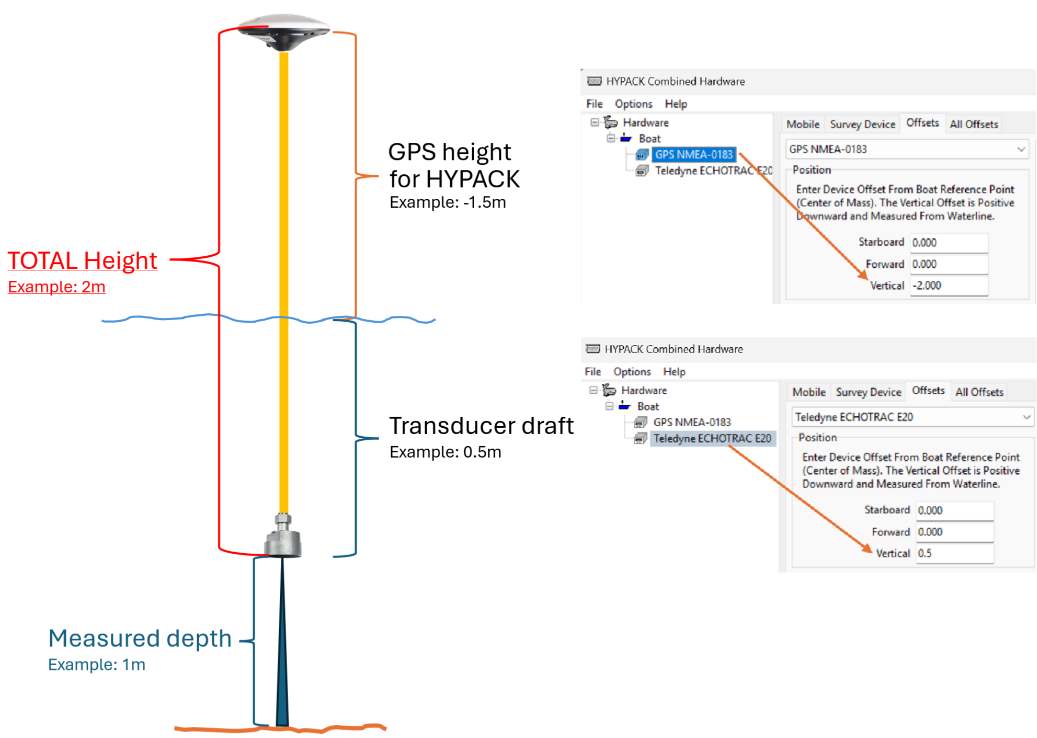
Method Two

Once you have your draft measured, break up the total measured height into a GPS height and a sonar draft as measured from the water surface. The sonar draft will be entered into the echosounder user interface and the vertical height of the GNSS, from the water, will be entered into the GPS driver as a negative value. The vertical value in the sonar driver will be zero as the sonar user interface will already be accounting for the draft in the data it sends to HYPACK®. The downside of this option is that if the draft value was entered incorrectly, it will be difficult to fix. Data recorded by HYPACK® does not contain any values entered into the sonar user interface.



Method Three

This method is generally the preferred method. It is identical to method two, however instead of entering in the draft of the sounder into the sonar interface, the value is entered into the HYPACK Combined Hardware settings. This makes it very easy to change if the value needs adjusting.



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Sound Velocity

A sonar does not measure the depth, a sonar only measures the 2 way travel time of a ping and then calculates the depth based on the sound speed entered into the echosounder. In most survey grade echosounders, users can enter in a value. There are two primary methodologies used for the application of sound speed. The methods can be combined for a hybrid method if desired. The methods discussed here assume that you have a sound velocity profiler. If you do not, then you will need to conduct a calibration bar check to determine the proper sound velocity to enter into the echosounder.

Method One

Lower the sound speed profiler through the water column and determine the average sound speed of the water column. This value will then be entered into the echosounder. During processing, the data will already be sound speed corrected, and no other action is required. If you do wish to apply sound speed profiles, then you will need to know what value was entered into the echosounder. This will then be entered into SBMAX64 so that the sound velocity profile can be properly applied to your data. While this method is perfectly acceptable, it does require that you take proper field notes, since in most cases the sound speed entered into the echosounder is NOT sent to HYPACK® and could result in errors during processing if a sound speed profile is used.

Method Two

If you intend to apply a sound speed profile(s) to your data, then you may want to consider leaving the sound speed entered into the sonar at a static value regardless of the water conditions. Many who utilize this will keep 1500m/s (or 4921.26 ft/s) entered into the sonar. This allows the processor to always know what was entered into the sonar, allowing the easy application of sound speed profiles. The downside of this is that the depths acquired in the field will not be accurate and will require the application of sound speed profiles for proper final depths.

Conclusion

While single beam survey is often the gateway to hydrographic survey and is, in comparison to other types of survey devices, “simple”, it is not without its pitfalls. Understanding how your acquisition system operates, where offsets are entered, and the different methodologies will go a long way in ensuring that the data you collect with the simple single beam is as accurate as possible. If you have any further questions about your setup or the methodology, HYPACK support (help@hypack.com) is here to help.

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