STARFISH HULL-MOUNT SONAR SYSTEM USER GUIDE

CONTENTS

INTRODUCTION

Thank you for purchasing your hull-mounted StarFish Seabed Imaging System, a revolutionary high definition hull-mounted side-scan sonar system which produces near photographic quality sonar images of the seabed.

Whether surveying lakes, rivers or the open ocean for dive sites, submerged structures, shipwrecks or research purposes, StarFish gives you the capability to capture detailed images of the seabed for work or play, making hi-tech seabed imaging accessible to anyone. With StarFish the seabed is your playground…

Simply fix the StarFish side-scan sonar transducer to the hull of a vessel, large or small, to capture real-time digital images of the seafloor below. StarFish is truly 'Plug and Play' connecting to any Microsoft® Windows® based PC or laptop via a USB connection.

The simple intuitive StarFish "Scanline" software makes seabed imaging extremely easy for novices and experienced side scan sonar users alike.

Before proceeding, we recommend that you read the safety, installation and operation guidelines in this user guide, in order to get full benefit from the features of the StarFish system.

We hope you get many years of trouble free use from your StarFish sonar. However, should you have any difficulties please refer to the "Product Support" section at the end of this manual for details on how to obtain technical support, upgrades and repairs.

IMPORTANT SAFETY INSTRUCTIONS

Before using your hull-mounted StarFish Seabed Imaging System, please read and follow these safety instructions.

Throughout this document the following symbols are used to indicate special precautions or procedures you should note…

WARNING!
This symbol indicates a warning you should follow of to avoid bodily injury and damage to your equipment.

CAUTION
This symbol denotes precautions and procedures you should follow to avoid damage to your equipment.

NOTE
This symbol denotes special instructions or tips that should help you get the best performance from your StarFish system.

Safety guidelines continued on next page…

ELECTRICAL SAFETY

- The AC power adaptor and surface control box are **NOT** protected against the ingress of water, so take care to avoid exposing the unit to sources of conductive liquids. Dry wet hands before handling the AC power adaptor or surface control box.
- Do not attempt to disassemble or service this product yourself (outside the scope described in this manual). Contact StarFish technical support for any maintenance, spares or repair work required.
- Do not overload a mains supply outlet, extension cord or adapter as this may result in electric fire or shock.
- Do not modify the power cord or plug.
- Do not place the AC adaptor or power cord near any heat sources that may melt the protective insulation.
- Do not use this product if any of the cabling, or housings of its component parts appear to be damaged or compromised for the ingress of water.
- Do not use (and ensure the product is unplugged) in situations where a power-line surge may occur (such as a lightning storm), or if the product is not used for a prolonged period of time.
- Ensure that the power supply has suitable earthing, and electrical shock risk is minimised through the use of fusing and residual-current-detection (RCD) devices.

OPERATIONAL SAFETY

- Do not rely on the product to necessarily represent the immediate sub-surface conditions below the boat, and as such this product should not be used as a direct means of avoiding submerged objects, shallow water & grounding, collisions with other vessels, boat damage or personal injury. If you are in doubt about any of these hazards, always operate your boat and sonar at reduced speeds, and proceed with caution.
- Do not rely on this product as a navigational aid.
- Do not allow the sonar transducer cable to obstruct or present a hazard to other personnel on the deck area or passage-ways of the boat. Use the provided cable-tie to coil and secure any surplus cable.
- Do not rely on the connection between the electronics box and the transducer cable, as a means of securing the sonar to the boat. The sonar transducer head should be fixed directly to the boat hull.

OTHER PRECAUTIONS

For storage and maintenance information, please refer to the section “Care Of Your Starfish” (see page 19).

If you have any other safety or operational queries, please contact StarFish technical support (see page 21).

WHAT YOUR SYSTEM CONTAINS

Before proceeding, please check that your StarFish system box contains the following items…

- StarFish hull-mount sonar transducer head (with supplied cable).
- StarFish transducer hull mounting bracket.
- StarFish sonar top-box electronics module.
- AC to DC universal power adapter (and international plug adaptors).
- DC power lead – cigar plug (fused) to 2.1mm plug.
- DC power lead – cigar socket to crocodile clips.
- USB 2.0 Cable (type-A to type-B connectors).
- StarFish “Scanline” software and drivers CD.
- User Guides.
- Bag of tools & sundries
    - 5 × M6×25mm stainless steel button-head screws,
    - 1 × 4mm Allen key

You will also need…

- Microsoft “Windows XP”, “Windows Vista” or “Windows 7” compatible computer (or laptop), with 1 free USB port (minimum).
- Battery (for DC operation) or suitably protected AC mains outlet (see page 6).

Additionally, you may also require…

- 10mm spanner for adjusting the angle transducer on the hull mounting bracket.
- Suitable fasteners to attach the mounting bracket to the hull of your vessel.
- Clips to secure the transducer cable to the hull of your vessel.

GETTING STARTED

To get started straight away, you can use the accompanying “Quick Start” guide to get up-and-scanning, or read on for further more detailed operational instructions and tips.

For further details on installing and operating the “Scanline” software package, please refer to the “StarFish Scanline Software User Guide” booklet.

Note: Do not connect the sonar USB electronics to the PC until the “Scanline” software and drivers have been installed – this will simplify the installation procedure.

SETTING UP THE SYSTEM

CHOOSING A POWER SUPPLY

Before setting up your StarFish system, you first need to decide on the power source you will use – either…

- A DC supply (such as a battery or boat electrical system), or
- Mains from the universal AC-DC adapter included with the system.

While the StarFish has internal voltage and current protection circuitry, any DC supply you use should be externally fused with a quick blow fuse rated at 1A.

For best performance of the StarFish, you should ensure any power source is "clean", meaning it is free from electrical noise possibly caused by mains-inverters, electrical motors or any other similar "high-current switching" devices.
Additionally, for DC supplies, the source should be a fully regulated and smoothed power source – a dedicated battery is ideal for this.

DC POWER

In marine conditions, where there is a high chance of equipment getting wet, the use of a low-voltage DC power supply is always recommended.

The StarFish electronics module has a 2.1mm DC input socket that will accept voltages between 9V and 28V, and will require a supply capable of delivering 5W. Typically this means the StarFish will require just under 500mA at 12V, or just under 250mA at 24V.

As DC supplies come in many varieties, several adaptor cables have been included with your StarFish.

- Use the "Cigar-Plug to 2.1mm cable" to connect your StarFish to either a 12V or 24V system. The plug itself can be disassembled to access the fuse inside it.
- Use the "Crocodile-clips to Cigar-Socket" adapter cable, for connecting to battery terminals, or other similar power sources.

If you are making your own wiring loom for the StarFish, you should ensure that the centre pin of the StarFish power connector is the positive DC voltage, and the outer connection of the plug is ground (or negative).

AC (MAINS) POWER

The AC power adapter is included for situations where the electronics will be used in a protected and dry environment (such as a boat wheel-house), and where a suitably fused and protected mains supply is available.

- The AC adaptor will accept voltage in the range of 100V to 240V AC, and 47Hz to 63Hz.
- Four universal adaptor plates are supplied with the power supply, allowing it to be used in most countries.

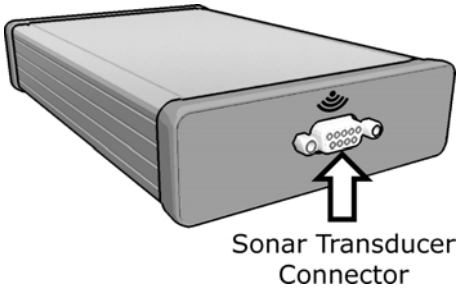
When using the AC (mains) power supply, remember that electricity and water do not mix.
To avoid electrical shock, you should only use the AC supply in a dry and enclosed environment, such as a cabin on board a boat.
Ensure the supply has suitable protection such as quick-trip circuit breakers and an RCD.
Only handle the StarFish equipment with dry hands.

CONNECTING THE COMPONENTS

Having chosen your power source, the next step is to connect up the components of the StarFish system.

If this is the first time you're using the StarFish system, it is recommended you install the "Scanline" software and USB hardware drivers on your laptop/PC before connecting the electronics module to it. Refer to the accompanying "Scanline User Guide" for details on how to do this.

Once the "Scanline" software and drivers are installed, make the following connections…

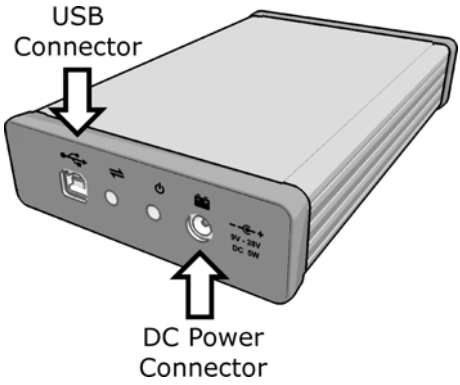


If possible, turn off the power supply – if this is not possible, make the power connection last.

1. Connect the StarFish sonar transducer head to the "top box" electronics module, with the 9-Way D-Type connector, and securing thumb-screws.

2. Connect the electronics module to a USB port on the laptop/PC using the supplied USB lead (type-A connector to type-B).

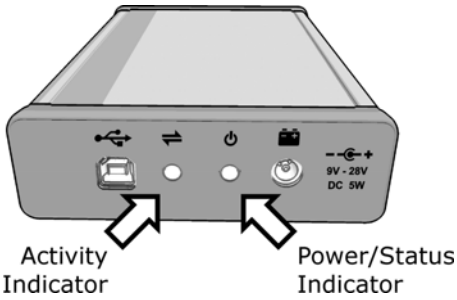
3. Connect DC power to the electronics module with the 2.1mm power jack – this may be from a DC source, or the included AC-DC adapter. Follow the selection and safety guidelines in the "Choosing A Power Supply" section above.



4. Finally, once you are happy with the connections, turn on the power.

When powered up, the "Power/Status Indicator" will illuminate and start to flash – indicating that the Topside box has correctly initialised.

The "Activity Indicator" will not illuminate until the USB connection is made, Scanline is running and configured correctly.



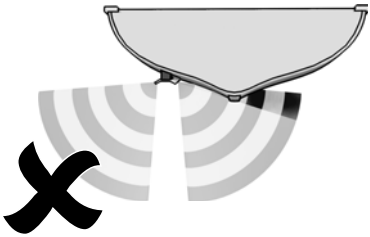
CHOOSING A MOUNTING LOCATION

Before you can start using the hull-mounted Starfish Sonar system in the field, you will need to mount the sonar transducer to the hull of you boat. Correct mounting of the sonar is essential in order to achieve the best image results, and as each hull is different you should consider the following points when deciding on a suitable mounting location…

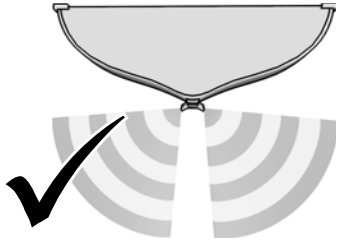
Avoid creating acoustic shadows…

The hull mounted StarFish transducer has transmitter and receiver elements located on either side of the moulding that are angled 30° down from the horizontal, and acoustically transmit sound in a “fan beam” of narrow width (refer to the specification of your StarFish product for the exact width), but wide vertically, with most of the acoustic energy confined to the centre 60° of the beam.

The arrangement allows the StarFish to perform well in shallow water at long ranges, and see almost directly below it, but incorrect placement on the hull could cause “acoustic shadows” or “reflections” to be produced from the hull, keel or rudder.



In this position, mounted directly on the hull, the keel is casting a shadow on the starboard channel

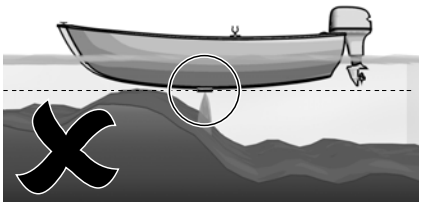


In this position, mounted on the keel, no other parts of the hull are obstructing the acoustic beams.

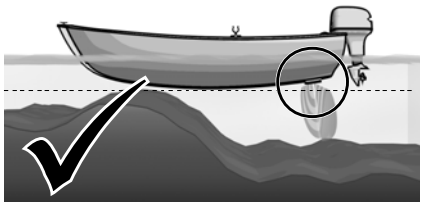
Acoustic shadows will create blind spots in the sonar’s field of vision and may reduce its maximum working range.
Reflections from the hull may create a ‘ghost’ or mirror image of the opposite channel on the sonar display.

Reduce vulnerability to grounding

When mounting the sonar on your vessel, make sure there is always a point on the hull that is lower than the transducers location. This will reduce the risk of damage to the transducer should you run aground or collide with any submerged obstacle.



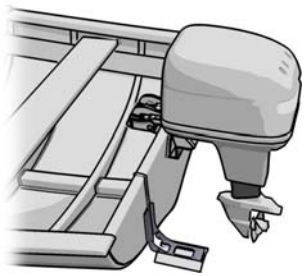
In this position, the transducer is vulnerable to submerged hazards



Above, the keel at the centre of the boat is lower than at the stern, and offers protection to the transducer.

Position in relation to the vessels propeller

Ideally the StarFish transducer should be mounted to the vessels hull in front of the vessels propeller, as this introduces small air-bubbles into the water which in-turn act as reflectors of sound and degrade the range and quality of the sonar imagery.



If using an outboard motor to propel and steer your boat, ensure that the propeller does not touch the transducer when the steering is at its extremities.

Try and keep a minimum distance of 400mm between the transducer and propeller to minimise mechanical interference (noise).

If it is not possible to mount the transducer in front of the propeller, efforts should instead be made to mount the transducer lower than it, such that its turbulence does not obstruct the acoustic beams.

Avoid cavitation & turbulence

When mounting the transducer onto the hull of your boat, it is important that a location is chosen that under normal conditions is known to be free from turbulence and aeration. You should also ensure the transducer is angled such that cavitation and turbulence is minimised on the transmitter and receiver surfaces as this may distort or degrade the sonar imagery. The figures below illustrate this principle…

Transducer is angled up.

Transducer is level.

Transducer is angled slightly down.

Avoid mounting the transducer behind features on the hull of your vessel (such as rivets, strakes or steps) that may introduce cavitation or turbulence into the water.

MOUNTING THE SONAR TRANSDUCER

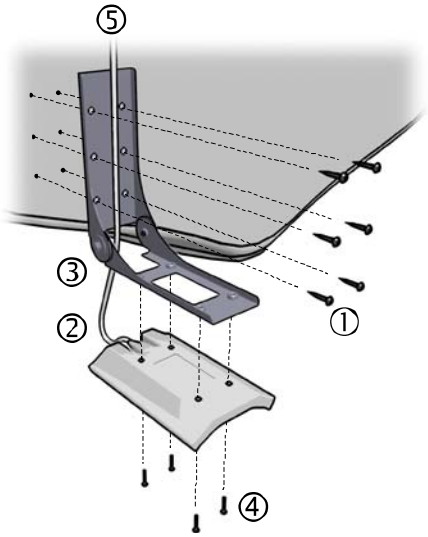
You may choose to mount the sonar transducer directly to the hull or keel of your boat (following the recommendations discussed previously), although where possible we would recommend the use of the additional mounting bracket and the following procedure…

① Secure the top part of the bracket to a flat surface on the hull or keel of you boat, using screws, bolts or other fixings depending on its construction.

② Pass the transducer cable through the hole between the two halves of the mounting bracket. Ensure you have enough slack cable to allow the bracket to pivot freely without the cable becoming taught.

③ Using a 10mm spanner, tighten the bolts on the hinge of the bracket to fix the mounting angle of the transducer.

④ Using the 4mm Allen key included, secure the black moulded transducer assembly to the underside of the mounting bracket.
The label on the transducer indicates the front (and hence port and starboard channels).



⑤ Use small cable clips to secure the remainder of cable to the hull of the boat and prevent it fouling on any other equipment.

When attaching the sonar transducer, mounting bracket or cable to the boat, choose a suitable location and fixing such that the watertight nature of the hull is not compromised! If in doubt, please contact the manufacturer of your vessel.

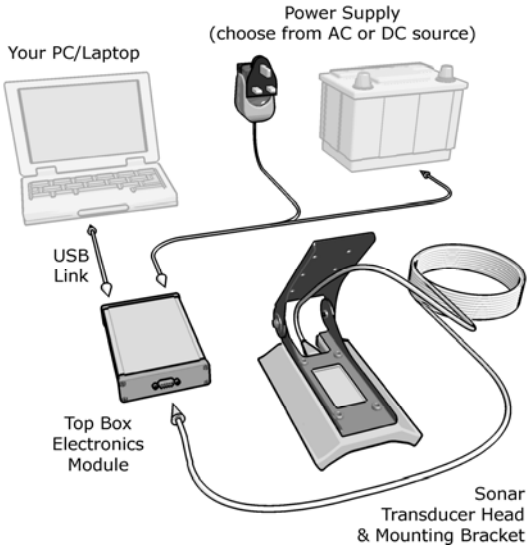
The cable length on the transducer may be increased up to a maximum of 20 metres using a “twin, screened, twisted pair” cable. Contact StarFish technical support for details of available extension cables.

When routing the transducer cable…

- Try to avoid running it parallel and in close proximity to other high-current cables, radio antenna cables or anything else that may be a source of electrical interference.
- Do not bend the cable to a radius less than 30mm as this may shorten its life.
- Do not use a fixing method that may cut, damage or excessively crush the cable.

OPERATING THE SONAR

To summarise, your system should be connected in a similar configuration to the figure shown below, and once you've installed sonar transducer on the hull (or other suitable mounting bracket) as described previously, you're ready to run the "Scanline" software, and start collecting data…



Refer to the separate "Scanline User Guide" for information on installing, starting and operating the software.

Operating the sonar is relatively straightforward, but there are a few guidelines and precautions you should observe to achieve the best results…

- Keep the boat speed constant, and ideally between 1 and 4 knots for the best results. At slower speeds more display lines will be acquired for smaller targets (giving a higher resolution image).
- Be aware of hazards to navigation and the sonar transducer. The sonar transducer head will only show you the depth of the seabed below it, not from the surface, and not in front of it. So, if you are scanning in close proximity to the seabed, you should be keeping a close eye on the sonar display.
- If in doubt of the underwater terrain or possible hazards, always assume the worst case, and give plenty of clearance between the sonar transducer and the seabed.

Please be aware that you should not rely on the sonar as a primary navigational aid for your vessel, or for avoiding shallows, submerged or mid-water hazards.

When the "Scanline" software is running, the "Activity Indicator" will flash to show that the StarFish is scanning and acquiring data.

See the following section on interpreting side-scan imagery, for further details on calculating the sonar's towing depth and altitude from the displayed data.

UNDERSTANDING SIDESCAN IMAGERY

Interpreting side-scan imagery may seem difficult at first, but with practice and some knowledge of how the sonar works, it doesn't take very long for an operator to understand what the seafloor is doing below the sonar, and if there are any targets on it.

Many people try to look at the pictures and understand them as you would a photograph, but this however is not strictly the case. In the following sections, we will look at several example images, and see how information can be obtained from them.

WHAT IS A SIDE-SCAN SONAR?

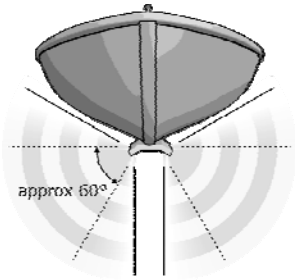
Sonar (**SO**und **N**avigation **A**nd **R**anging) and echo-sounding technology dates back to the 1920's, but it was only in the early 1960's that Dr. Harold Edgerton (an electrical engineering professor at the Massachusetts Institute of Technology) started to adapt his techniques on high-speed flash photography to acoustics, having concluded that photography was not best suited to the murky conditions underwater.

By sending "flashes" of acoustic energy into the water and recording the echoes, Edgerton (who later worked with underwater explorer Jacques Cousteau), developed a towed side-looking sonar that could create a continuous image of the seafloor.

By transmitting a narrow fan-shaped acoustic pulse (ping) perpendicular to its direction of travel, the side-scan sonar sends acoustic pulses outwards. The seabed and other objects reflect some of the sound energy back in the direction of the sonar (known as backscatter), and the travel time of the returned pulse is recorded together with its intensity.

As sounds travels at a known velocity (of approximately 1500 metres per second) through water, we can directly relate the time we received an echo, to the range of the target that reflected it.

This scan-line of information is sent to a topside computer for interpretation and display, and by stitching together data from successive pulses, a long continuous image of the seafloor is created, as the sonar is towed from the survey vessel.



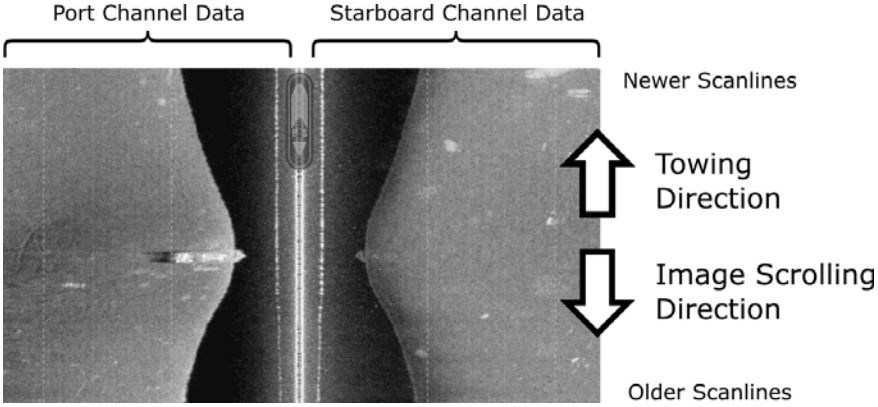
As mentioned previously, your StarFish has two transducers (transmitter and receiver elements) that are angled 30° down from the horizontal, and acoustically transmit sound in a "fan beam" of narrow width (refer to the specification of your StarFish product for the exact width), but wide vertically with most of the acoustic energy confined to the centre 60° of the beam.
This gives the StarFish the ability to see almost directly below it, to just above the horizontal.

However, despite this field of vision, the StarFish cannot determine where a target lies vertically in its beam (i.e. above or below it), as everything is translated to a planar 2D display.
For example, if there are two targets both 10 metres from the sonar (one horizontally level with it, and one directly below it, and are received on the same channel) they would both appear at the same point on the sonar display, as the display scale is based around time, and both echoes would arrive simultaneously.

With some experience though, image artefacts like "acoustic shadows" can help the operator make an educated guess to the size of targets and sea-bed features.

What Does A Side-Scan Sonar Image Look Like?

The figure below is a real image captured by a StarFish sonar, where each horizontal line is a representation of time versus the intensity of the reflected echoes. The further something is away from the centre line of the display, means the longer it took for the echo to be received.



In this figure, both the port (left) and starboard (right) channels are operating at the same time. The sonar is positioned in the middle of the topmost line, and as the sonar is towed through the water the image will scroll away from it as more data is added.

Calculating Depth Below The Sonar (Altitude)

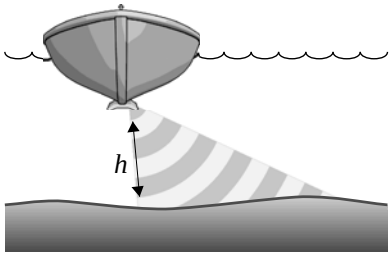
A useful measure to know when using a side-scan sonar is the height above the seafloor, so a safe distance can be maintained and hazards avoided.

Looking at the previous image, we can see a large black "hour-glass" shaped area in the middle of the display, where no echoes have been received.

In fact this area is showing us the height the sonar is above the sea bed.

As the figure opposite shows, the nearest object to the sonar will always be the seabed below it (assuming a relatively flat seabed).

However, it will take some time for the "bottom echo" to be returned, and as the display shows the received echoes from when the transmission started, this area appears black.



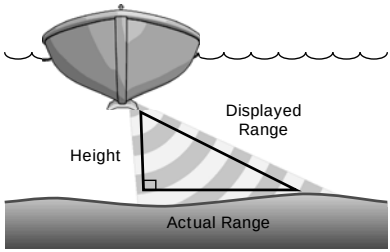
Therefore, the narrower the band of black is, the closer the sonar is to the seabed – and as the image is built up over time, if the sonar's altitude changes we actually start to see the profile of the seabed that the sonar has passed over.

This means in the figure above, the seabed gets shallower in the middle of the display, and then gets deeper again at the bottom.

CALCULATING THE DISTANCE TO A TARGET

As mentioned earlier, the sonar display shows the recorded echoes over a period of time, and we have seen how we can work out the depth below the sonar from this.

However, this also means that the range a target appears to be on the display is not the distance it lies at from the sonar horizontally across the seabed.



To understand why this is the case, consider the triangle shown in the figure opposite. As the sound waves travel from the sonar, they start to hit the seabed, and each point of contact returns an echo along the shortest path to the sonar.

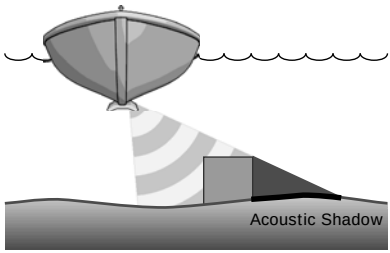
To work out the actual distance at which a target lies, you need to use the mathematical formula opposite…

$$\text{Actual Range} = \sqrt{\text{Displayed Range}^2 - \text{Height}^2}$$

ACOUSTIC SHADOWS

When sound from the sonar hits a submerged target with any height above the seabed, an acoustic shadow will be cast away from the sonar.

An experienced sonar operator can use the lengths of these shadows, along with knowledge of the sonar altitude to get an idea of the size and height of the object.



To help understand this, imagine you are in a darkened room, with a flashlight, standing above a ball. If you shine the flashlight down on the ball, a small shadow is cast around it, while if you lie down level with the ball and shine the light at it, a much longer shadow is produced stretching away from it.

This principle applies to side-scan sonar in a similar way; objects directly beneath the sonar will appear to have very small shadows, while objects at greater distances will have longer shadows because they are being illuminated (acoustically) on their side. The shadows of targets can be elongated further if the towing altitude of the sonar is decreased or if in shallow water.

REFLECTED TARGET INTENSITY

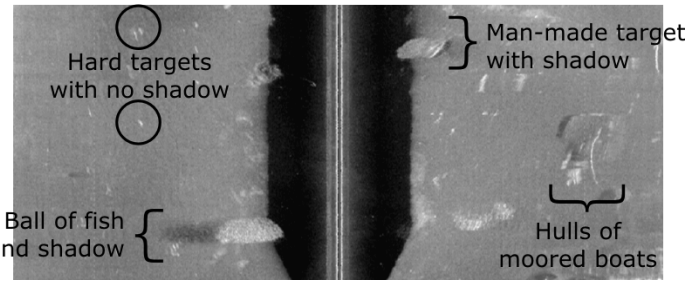
To complete our understanding of the basics of sonar imagery, we need to consider the brightness information (intensity of echo) shown on the sonar display.

As with a surface reflecting light, different surface textures and materials of targets have different acoustic reflective properties.

Typically the more the density of the target differs from that of water, or the more rigid its material is, the more sound is reflected back.

- Any target with a gas in (such as air) will act as an almost perfect reflector for sound, and will show as the brightest colour in the palette.
- Muddy or silted lake and sea beds will generally show up as a low-intensity background colour, as mud is a good sound absorber and contains water.

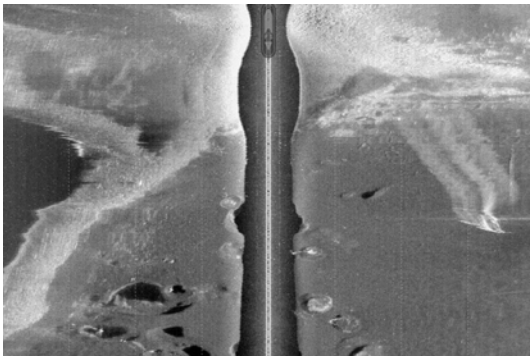
The example image below shows several bright targets of interest…



Taking what we already know about sonar imagery into account we can interpret the following…

- White ‘dots’, without any form of shadow are most likely either flat hard targets on the bottom or large mid-water fish (with their air-filled swim-bladder showing up on the sonar).
- At the bottom of the image we can see a bait-ball of fish – identifiable as large spherical structure that protrudes above the seabed profile (there is a faint and fragmented shadow extending away from it, implying it is not a single solid target).
- On the right of the image, we can see several vertical curved white lines. These are most likely the hulls of moored boats, and close to them we can see the square outlines of the concrete mooring blocks.
- At the top of the image, there is a large target. As it appears on both channels, and we can see its profile, we know the sonar has passed directly over it. The bright geometric echoes on it indicate it is probably man-made, and there is an acoustic shadow visible on the right portion of it, showing it has height.
  It is most likely this is the wreck of a sunken vessel.

EXAMPLE SIDE-SCAN SONAR IMAGES



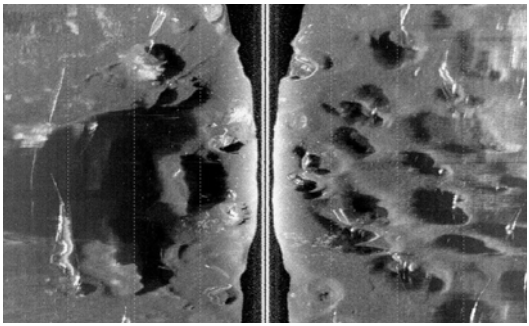
Lake Bed
Scan showing boat moorings at the bottom (concrete blocks in craters of silt).

The dark area on the left channel is the shoreline.
A boat with wake is visible on the right.

At the top of the right channel, it can be seen that the bottom has a rockier texture, and appears brighter than the silt in the rest of the image.

Cable Car Ferry
Lake bed beneath a cable-hauled car ferry.
The two cables are visible above the bottom, crossing beneath the sonar.

The movement of the cables has exposed the bedrock of the lake, causing a brighter reflection.
The grooves are visible on the centre profile on the lakebed, and the shore and slip-way are visible in the top left.



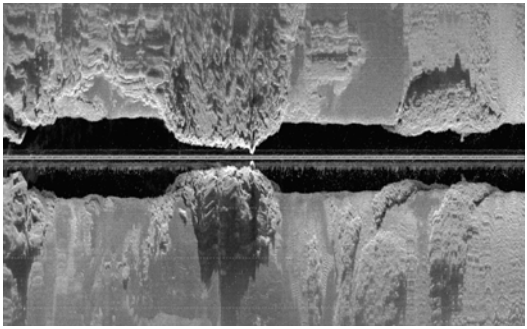
Marina
Shallow water with moored boats.
The bright white targets of the hulls are visible, above “craters” in the silt, caused by the movement of the mooring cables.

Note the large acoustic shadow on the left channel, caused by a raised area of the seabed being almost level with the sonar in the shallow water.

Coral Reef
Horizontal image orientation showing a scan over coral reefs.

At the extreme right of this image, ripples in the sand are visible, while each coral outcrop has clearly visible shadows.

Note how close the sonar came to a small outcrop at the centre of the image!



GAIN & CONTRAST SETTINGS

When operating your sonar, the adjustments you will make to the gain and contrast controls are critical in achieving good side-scan imagery. This section examines the function and purpose of these controls…

Gain
The software gain control is similar to the volume control on a home hi-fi system, or the brightness control on a television.
The gain control sets how the incoming scan-lines of data (from the sonar hardware) map onto the display's colour palette.

- Increasing the gain value will make all areas of the display image appear brighter, while decreasing it will make the whole image appear darker.
- For general operation, a gain value of 30% (-28dB) is recommended.

Contrast
The function of the contrast control is slightly more complex to understand than that of the gain control.
The contrast value sets the palette range that the incoming signal will be stretched or shrunk to fit.

- A lower contrast value means that the image will transition from dark to bright colours more quickly than a higher contrast value.
- For general operation, a contrast value of 30% (38dB) is recommended, but can be reduced to 25% to enhance shadows and submerged targets.

The best way to understand the operation of the Gain and Contrast controls is to experiment with these values while scanning the sonar over a known area of seabed.

Generally, having set the operational range of the sonar, you should then set the gain to a level where the background noise is just visible. This should ensure that quiet signals are visible at the extremities of the display, whilst the central mid-water areas and seabed profile have good definition.

Then, when scanning, adjust the contrast to give the desired sharpness of targets – lowering the contrast will make echoes appear brighter, while keeping shadows dark.

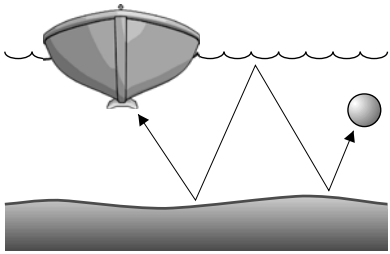
SHALLOW WATER & CHANNELS

When operating in shallow water and channels, you may experience a "ghosting" effect caused by acoustic returns from previous sonar "pings" still bouncing between targets and the sonar receivers.

To reduce these effects, use a larger "range" on the sonar display, which should have the effect of slowing the "ping rate" and allowing time for these echoes to dissipate.

In shallow water, you may also see distortion on long range targets, caused by "multi-path" phenomenon – where sound is reflected between the seabed and surface before hitting the target.

Due to surface waves and chop, the effect can manifest its self as ripples on distant targets.



TIPS FOR GOOD IMAGERY

Vessel Speed
When towing the StarFish, remember that it is “pinging” at a fixed rate (depending on range). The faster you tow the fish, the more compressed images will appear on the display.
For long ranges, try to tow at speeds between 1 and 3 knots, while shorter ranges can be used with speeds of 3 to 6 knots.

Water Depth
The depth of water beneath the sonar is an important factor to consider when interpreting heights of submerged objects from their acoustic shadows. In shallow water acoustic shadows from targets appear very elongated (like shadows cast from objects at sunset), while in deep water the seabed will appear more as a “birds-eye” type view with minimal shadows.

Mounting Position
The position and method of mounting the transducers on the hull is probably one of the biggest factors in determining overall image quality. As discussed in previous sections, the transmitter and receiver faces on the transducer should…

- Have no obstructions in their acoustic beams that may cause shadows or reflections.
- Be clear of any turbulence or cavitation from the hull in front of them.
- Be clear of turbulence or aeration caused by the vessels propeller.

Boat Navigation
When surveying an area, think about the course you will steer your vessel over. Try to divide the area into a grid of long straight runs, with 180° turns at the end.

Remember that as the boat turns, the acoustic beams from the inside of the turn will overlap, while the outside ones will be covering more seabed – consequently the imagery produced will appear distorted and hard to interpret in these areas.

Give plenty of clearance between your boat and other vessels or surface/mid-water hazards, and try and avoid the aerated water left in the wake of other boats, as this will be acoustically visible for some time should you cross through it with your sonar.

Waves, Wake and Surface Chop
As your StarFish is operating close to the surface, its imagery may be distorted by the motion of the boat due to waves and surface chop on the water, or it may receive reflections from these at longer ranges.
Consequently, your StarFish will not perform well in rough stormy conditions.

Remember, that when in a boat, your own safety is paramount and should not be compromised trying to achieve good sonar imagery.

CARE OF YOUR STARFISH

OPERATIONAL CARE

In addition to the points highlighted in the "Important Safety Instructions" section (see page 3), please observe the additional precautions…

- Do not operate the product near a source of heat that may cause the operational temperature parameters to be exceeded (see specifications on page 26), or stack other heat generating equipment on top of the unit.
- Always use the electronics module on a stable, non-slip, rigid, flat and lint-free surface.
- Make sure the product is more than 10cm away from any other appliance that may be susceptible to electromagnetic interference.

MAINTENANCE & CLEANING

When you have finished using your StarFish sonar, you should…

- Disconnect the product from the power supply before attempting any maintenance or cleaning.
- Remove any weed, or other detritus, from the cable and sonar head, that may have been collected during its operation.
- Wipe, with a damp cloth, any salt-water spray that may have inadvertently settled on the surface of the "top box" electronics module and connectors.

Additionally please observe the following precautions for cleaning and maintenance…

- Do not clean with solvents, and only use a damp cloth on the exterior of the unit.
- Do not undertake maintenance of the unit, outside the scope of that defined within this manual, unless instructed to do so by *Tritech International Ltd* technical support.
- Do not insert extraneous object (metal or other alien substance) into the unit or any of its connector apertures.

STORAGE

When storing or shipping the StarFish system, please observe the following…

- Avoid excessively bending or kinking the cable (below a radius of 30mm), as this could reduce its operational life.
- Avoid excessive and large fluctuations in temperature.
- To prevent corrosion, remove any salt or other residues from the product before storage out of the water.
- Store in a well ventilated enclosure after use, to allow any moisture on system components to evaporate naturally.
- Ensure no point-load is exerted on the transducers on either side of the sonar transducer head.

TROUBLESHOOTING

Below is a table of common problems and solutions, but if you have a problem that cannot be solved from the table below, or an issue that is not covered, please contact StarFish technical support - see page 21 for further details.

Note: For software issues and problems, please refer to the accompanying “Scanline User Guide”.

Problem…	*Solution(s)…*
Electrical interference	This is most commonly seen as bright small snow-like dots over the image – usually with some form of regular repeating pattern. The most common cause is interference from other high-current switching electrical devices (such as mains inverters, or motors) connected to the same power source as the top box electronics module. Try methodically turning off other electrical devices to find the cause, or running the StarFish from its own dedicated supply (or battery).
Acoustic noise	This is most commonly seen as large stripes or pulses of varying brightness over the image, usually with some form of regular repeating pattern. Try to identify and, where possible, remove the source of the acoustic noise. Most commonly, your boat, or other vessels, may have an echosounder that is running at a frequency close to the operating band of the StarFish.
Image ghosting or mirroring	This problem may occur if the StarFish is receiving echoes from the hull or keel of the boat. Try repositioning the transducer so the acoustic beams are not obstructed from the transmitter faces. This problem can also occur in shallow water, where the high-intensity transmission from one transducer is being received by the other. If possible, use the software to display only a single channel (and prevent transmissions from the other); this will reduce the inter-channel cross-talk.

PRODUCT SUPPORT

STARFISH WEBSITE

Visit "*www.starfishsonar.com*" for the on-line home of the StarFish product family. From here you can get the latest news, software and firmware updates. Additionally, you can see sonar imagery from other StarFish customers, and submit any interesting images you collect.

TECHNICAL SUPPORT

If your StarFish sonar is not operating properly, we would suggest that your first try the 'Troubleshooting' section of this manual and the electronic documentation provided with the product to see if the problem can be easily remedied.
If you need further support, you can contact us at…

- **Web** www.starfishsonar.com/support/support.htm
  (for access to on-line resources and a support request form)

- **Email** support@starfishsonar.com

- **Call us** +44 (0)1224 746979
  (9:00am to 5:00pm, Monday to Friday, GMT)

For all of the above please provide the following information, where appropriate and if possible, to help us with your technical support request…

- Part and Serial Numbers of the system components. These are located on the labels of each item, and are in the form "BPxxxxx.xxxxxx".
- Version number of the 'Scanline' software you are using.
- The operating system name, version, type (32 bit or 64 bit) and service pack upgrade your computer is using.
- Brand and model of your computer (processor type and memory configuration is also useful if known).
- Name of the stockist, supplier or retailer where you purchased your StarFish system.

If you have to return your StarFish product for servicing, please…

- Contact us (using the details above) for a "Returned Materials Authorisation" (RMA) number before sending your StarFish.
- Pack your StarFish back in the original packaging (or other suitable container), and include written documentation including your contact details (including contact phone number), the RMA number and a description of the problem and any symptoms occurring.
- If your product is still under warranty, please include a copy of your receipt (showing proof and date of purchase).
- Please return the product back to Tritech International Limited, using an insured courier and delivery confirmation.

Note: Due to the expansion of equipment capabilities and the fact that new products are continually being introduced, this manual cannot detail every aspect of the product operation.

LIMITED WARRANTY POLICY

Tritech International Limited (herein after referred to as TIL) warrants that at the time of shipment all products shall be free from defects in material and workmanship and suitable for the purpose specified in the product literature.

The system warranty commences immediately from the date of customer acceptance and runs for a period of 365 days. Customer acceptance will always be deemed to have occurred within 72 hours of delivery.

Note: Any customer acceptance testing (if applicable) must be performed at either TIL premises or at one of their approved distributors unless mutually agreed in writing prior to despatch.

Conditions:
These include, but are not limited to, the following:

1. The warranty is only deemed to be valid if the equipment was sold through TIL or one of its approved distributors.
2. The equipment must have been installed and commissioned in strict accordance with approved technical standards and specifications and for the purpose that the system was designed.
3. The warranty is not transferable.
4. TIL must be notified immediately (in writing) of any suspected defect and if advised by TIL, the equipment subject to the defect shall be returned by the customer to TIL, via a suitable mode of transportation and shall be freight paid.
5. The warranty does not apply to defects that have been caused by failure to follow the recommended installation or maintenance procedures, or defects resulting from normal wear & tear, incorrect operation, fire, water ingress, lightning damage or fluctuations in vehicles supply voltages, or from any other circumstances that may arise after delivery that is out with the control of TIL. (Note: The warranty does not apply in the event where a defect has been caused by isolation incompatibilities.)
6. The warranty does not cover the transportation of personnel and per diem allowances relating to any repair or replacement.
7. The warranty does not cover any direct, indirect, punitive, special consequential damages or any damages whatsoever arising out of or connected with misuse of this product.
8. Any equipment or parts returned under warranty provisions will be returned to the customer freight prepaid by TIL
9. The warranty shall become invalid if the customer attempts to repair or modify the equipment without appropriate written authority being first received from TIL.
10. TIL retains the sole right to accept or reject any warranty claim.
11. Each product is carefully examined and checked before it is shipped. It should therefore be visually and operationally checked as soon as it is received. If it is damaged in anyway, a claim should be filed with the courier and TIL notified of the damage.

Note: TIL reserve the right to change specifications at any time without notice and without any obligation to incorporate new features in instruments previously sold.

Note: If the instrument is not covered by warranty, or if it is determined that the fault is caused by misuse, repair will be billed to the customer, and an estimate submitted for customer approval before the commencement of repairs.

NOTICES

HANDLING RECOMMENDATIONS

The StarFish system contains sensitive electronic components that may be damaged by an Electrostatic Discharge (ESD) if handled incorrectly. To minimise risk, avoid dismantling the unit, touching any exposed electrical contacts on external connector, or inserting anything other than the recommended cabling into the connectors.

WASTE ELECTRICAL & ELECTRONIC EQUIPMENT STATEMENT

Tritech International Limited is very aware of its responsibilities to the environment and to the sustainability of the resources of our planet.
Under the European Union (EU) directive on 'Waste Electrical & Electronic Equipment' (Directive 2002/96/EC), from August 13, 2005, products categorised as electrical or electronic equipment cannot be discarded as municipal waste by placing in landfill, dumping in the sea or incineration. SEPARATE collection is mandatory.

At the end of its life, you should either return this system and its associated leads & accessories (if appropriate) to Tritech International Limited with a certificate of decontamination (we reserve the right to protect our staff from the effects of any contamination) or it should be sent to an appropriate treatment or recycling agency.

RESTRICTION OF HAZARDOUS SUBSTANCES STATEMENT

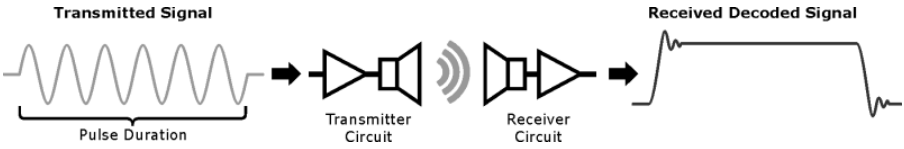
Under the European Union (EU) directive on the 'Restriction of Hazardous Substances' (Directive 2002/95/EC), from July 1, 2006, electrical and electronic equipment cannot contain lead ("lead free"), mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE).
All components of the StarFish system, sold by Tritech International Limited, fully comply with this legislation where applicable.

APPENDIX A - HOW YOUR STARFISH WORKS

Your StarFish sonar uses the latest advances in high-speed digital signal processing and "Chirp" (**C**ompressed **H**igh **I**ntensity **R**adar **P**ulse) techniques at the core of its acoustic engine.
This section aims to help you understand the benefits of using Chirp acoustic techniques, by analysing and comparing these with the limitations of using conventional single frequency (monotonic) techniques.

MONOTONIC SONAR OPERATION

The figure below shows the relationship that exists between the transmitted single frequency signal and the output produced by the reflected target echo in the receiver circuitry of the sonar. It can be seen that the receiver does not decode each cycle of the transmitted pulse, but instead produces the envelope of its overall amplitude…



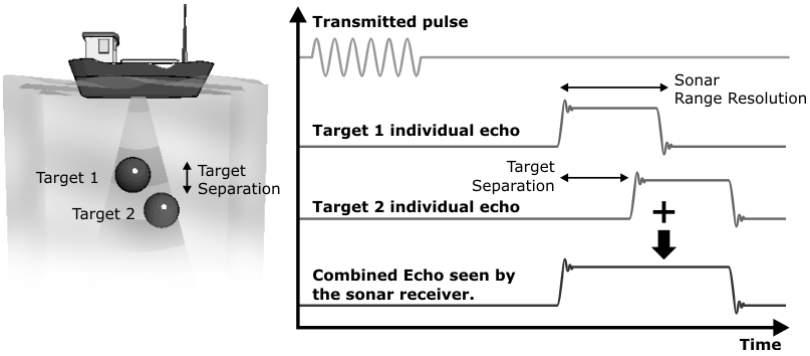
The ability of monotonic acoustic systems to resolve targets is better if the pulse duration is short (so these decoded pulses don't overlap); this, however, has its drawbacks.

Ideally, we need long transmit pulses to get enough acoustic energy into the water for - good target identification of the furthermost targets, but due to the Velocity Of Sound (VOS) through water (typically around 1500 metres/second), each pulse will occupy an equivalent distance related to its pulse duration – this is referred to as "range resolution", and can be found by the following equation…

$$\text{Range Resolution} = \frac{(\text{Pulse Length} \times \text{Velocity of Sound})}{2}$$

Example…
In a monotonic side scan sonar system, the pulse duration is typically 100 micro-seconds, and combining this with the VOS, a range resolution of 75mm is obtained.

The "range resolution" effectively determines the ability of the sonar to identify separate targets; so, using the example above, if two targets are less than 75mm apart then they cannot be distinguished from each other. The net effect is that the system will display a single large combined target, rather than multiple smaller targets, and any fine sonar details are lost, as shown below…

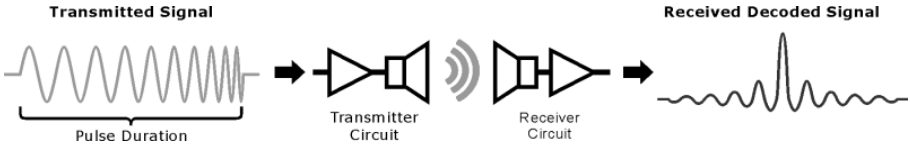


CHIRP SONAR OPERATION

Instead of using a pulse of a single carrier frequency, the frequency within the burst is changed (swept) through the duration of the transmission, from one frequency to another. For example, a StarFish 450 sonar operates at 430KHz at the start of the transmission, and at the end it reaches 470KHz (giving it a 40KHz bandwidth).

By constantly changing its frequency over time, this "chirped" transmission can be thought of as having a unique acoustic signature, and so if two pulses now overlap (as the targets are closer than the range resolution), we can use the known frequency-versus-time information to tell them apart.

The StarFish sonar receiver contains a pattern-matching circuit that looks for its transmitted Chirp being echoed back from targets, and its receiver now produces a sharp spike when a good match is found (compare this to the monotonic sonar, described previously, that produces an output the same duration as its transmit pulse)…



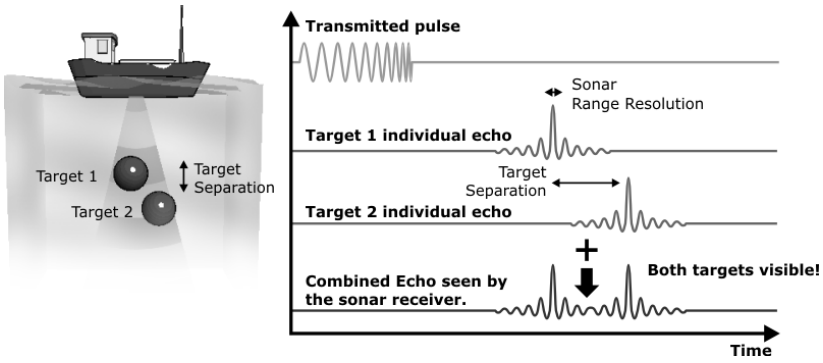
This means that the critical factor in determining range resolution is no longer the pulse length, but the bandwidth of the Chirp, so the range resolution can be found by…

$$\text{Range Resolution} = \frac{\text{Velocity of Sound}}{(\text{Bandwidth} \times 2)}$$

Example…
The bandwidth of the StarFish CHIRP system is typically 40kHz, and using the same VOS of 1500 metres/second, our new range resolution is 18.75mm… a theoretical improvement by a factor of 4 over the monotonic example above!

This figure below shows that on a chirped sonar, when two acoustic echoes overlap, the Chirp pulses do not merge into a single acoustic return (as their frequency is different from each other at the overlapping points), and the sonar is able to resolve and display the two targets independently.

Therefore, we now can have longer transmissions (and see targets further away) without a loss in resolution; and additionally, Chirp signal processing techniques offer improvements in background noise rejection (as the side scan sonar is only looking for a swept frequency echoes, removing random noise or out-of-band noise).



APPENDIX B – SPECIFICATIONS

SONAR HEAD Part Number	**StarFish 450H (5m)** BP00082	**StarFish 450H (20m)** BP00092
Frequency	450kHz CHIRP	
Operating Range	100m (328ft) per channel	
Horizontal Beam Width	1.7°	
Vertical Beam Width	60°	
Transducer Angle	Tilted Down 30° from Horizontal	
Length	195mm (7.68”)	
Width	130mm (5.12”)	
Height	35mm (1.38”)	
Weight (in Air)	0.7kg (1.54lb)	
Construction	Reinforced polyurethane rubber	
Colour	Black	
Depth Rating	50m (164ft)	
Inline Connector	N/A	

CABLE		
Fitted Length	5m (16ft)	20m (65ft)
Construction	Black polyurethane jacket with internal Kevlar reinforcing (strain) member	
Breaking Strain	>150kg (330lb)	
Minimum Bend Radius	30mm (1.2”)	
Inline Connector	N/A	

TOP-BOX Part Number	**450 Series** BP00019
Supply Voltage	90-264VAC, 47-63Hz or 9-28VDC
Power Consumption	6W (500mA @ 12VDC)
Power Interface	2.1mm DC jack socket
PC Interface	USB 2.0 B-Type connector
Sonar Interface	9-Way Female D-Type socket
Length	166mm (6.54”)
Width	106mm (4.17”)
Height	34mm (1.34”)
Weight (in Air)	0.4kg (0.88lb)
Temp Range	-5°C to +40°C (23°F to 104°F)
IP Rating	IP50 (Protection against ingress of dust, no protection against ingress of liquids)

Note: All data given above may be subject to change at any time.

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