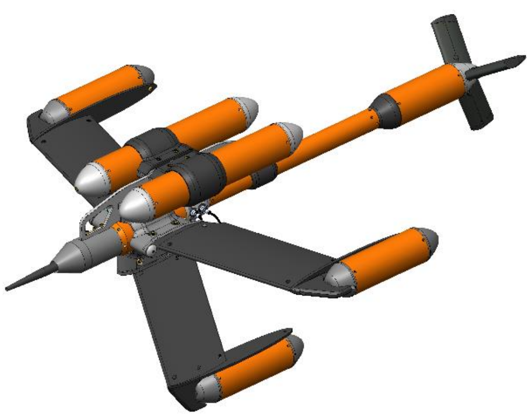
SeaQuest2

Operation Manual

Revision 1



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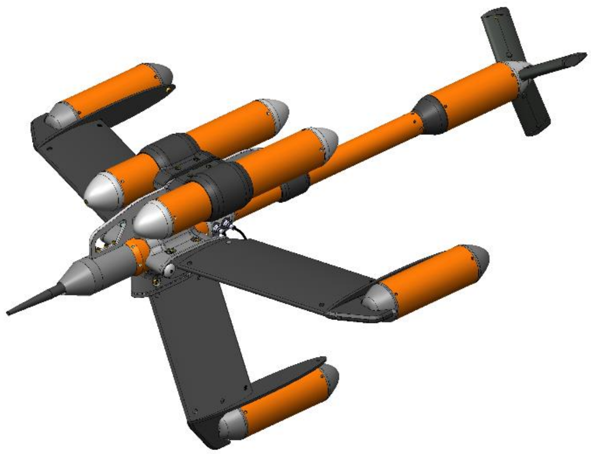
1 Introduction

The SeaQuest2 is a 3-axis magnetic gradiometer that is designed to detect ferrous objects and magnetic targets in marine environments. The SeaQuest frame contains multiple magnetic sensors separated by a fixed and known distance so that the total gradient of the local magnetic field can be measured directly. The SeaQuest is the first and only marine gradiometer that allows measurement of all three axial gradients simultaneously. These are: transverse (across track), longitudinal (along track), and vertical. Measuring all three gradients simultaneously is equivalent to the direct measurement of the Total Magnetic Gradient, also referred to as the Analytic Signal. The Total Magnetic Gradient is a superb metric for highlighting near-surface magnetic sources and suppressing the distant background, and is unaffected by the diurnal magnetic variation.



The SeaQuest2 frame is a significant improvement over the original SeaQuest, featuring a rigid and streamlined frame that reduces tow drag dramatically, and has fewer parts to assemble before deployment. The rugged SeaQuest2 platform is designed to be towed behind a vessel, and is exceptionally stable. SeaQuest2 comes equipped with a 3-axis gyro-compensated IMU.

The twin floats enable the SeaQuest2 to remain near the surface when not being towed. The floats are movable, which allows the user to set the pitch angle of the frame, thus offering control over the desired towing depth.

The built-in altimeter and pressure sensor keep track of the height above seafloor and depth below surface, while the IMU accurately monitors the attitude angles of the SeaQuest frame. All of this auxiliary data is made available to the data analyst in both real-time and post-processing.

SeaQuest2 is available in one standard configuration: with 4 sensors, enabling 3 axial pairs with the following fixed sensor separations:

Gradient Axis	Sensor Separation
Horizontal Transverse	1.5 m
Horizontal Longitudinal	0.81 m
Vertical	0.75 m

Table 1-1 - SeaQuest2 Sensor separations

SeaQuest2 is designed to work with Marine Magnetics BOB data logging and visualization software, which uses the specified sensor separations when computing the Total Magnetic Gradient (Analytic Signal) in real-time during the survey.

1.1 *SeaQuest2 system components:*

- Gradiometer frame that contains 2 wings, a keel and a tail, each equipped with highly-accurate Overhauser sensors, and a central pod with the driving electronics and auxiliary sensors.
- Altimeter single-beam echo sounder, with 1-90m range and 0.1m resolution.
- 3-axis gyro-compensated IMU, reporting the pitch, roll and yaw angles of the frame.
- Pressure (depth) sensor, with 300m range and 0.1m resolution.
- Tow cable connector and streamlined nose cone.
- High-strength marine tow cable, containing a single twisted wire pair, used for both power delivery and data transfer.
- Deck leader cable that is waterproof, but not designed to be submerged in water.
- Isolation transceiver for powering and communicating with the SeaQuest from the deck of a vessel.
- Choice of USB or RS232 interface cables that connect the isolation transceiver to a standard PC USB or RS232 port.
- 24V DC power supply, universally compatible with 100-240VAC 50/60Hz input.
- BOB data acquisition, visualization, and control software for Windows.
- External GPS (supplied by the user) capable of GPGGA and GPRMC data output at 1 Hz or higher. 5 Hz recommended. The GPS can be connected to the isolation transceiver to ensure best possible time synchronization accuracy between the SeaQuest readings and positions during the survey.

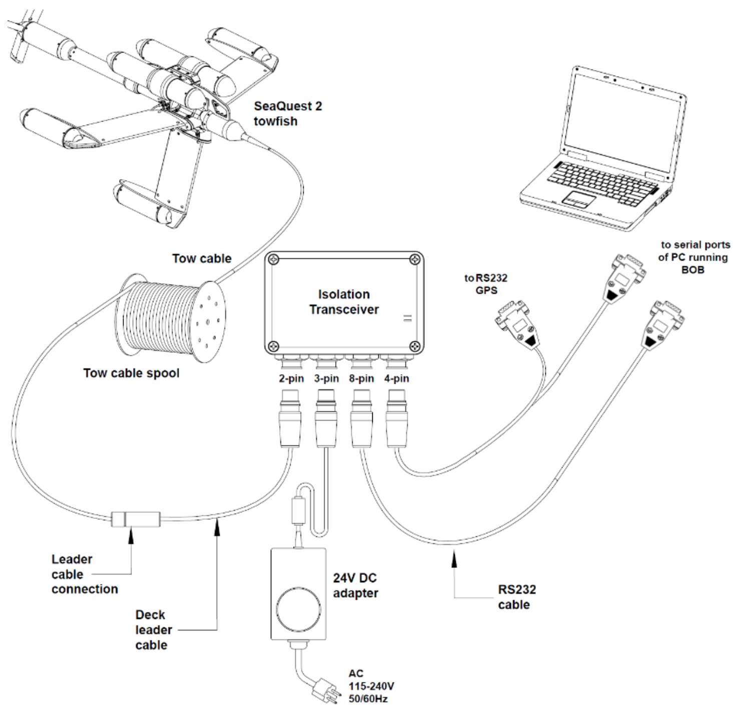


Figure 1-1 - SeaQuest2 System components with a GPS-enabled Isolation Transceiver.

A y-adapter branch of GPS cable connects to the Transceiver for ideal time synchronization with the towfish.

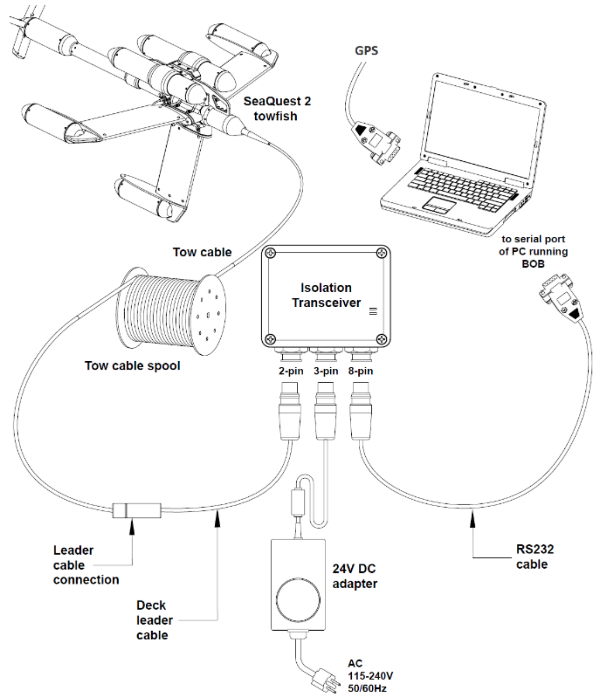


Figure 1-2 - SeaQuest2 System components with a standard Isolation Transceiver

GPS connects to a separate port on the PC. Data logging software pairs GPS data with magnetometer readings based on time, and maintains clock synchronization with the towfish.

1.2 Important Notes on Operation

Similarly to all high performance geophysical instrumentation, there are a few simple rules to ensure optimum operation of the SeaQuest:

- **The SeaQuest2 should never be submerged unless all sensor cables are plugged in. Failing to ensure this may result in leaks and damage to the electronics.**
- The platform must be towed completely submerged underwater, and ideally below the wave base, to ensure smooth motion. Do not allow the sensors to break the surface while measuring data.
- As with all magnetometers, the platform must be towed far enough behind the survey vessel, so that the magnetic influence of the vessel is negligible. Generally a minimum distance equal to 3 times the length of the survey boat is recommended.
- The SeaQuest requires a small crane or davit on your vessel for safe and easy deployment and retrieval. Never allow the frame or the sensor to hit hard surfaces or sides of the vessel, as it may alter the geometry of the frame and adversely affect the towing characteristics, or damage the sensors.
- Always calibrate the zero-level of the depth sensor at the surface before the survey, to ensure accurate readings. For best results, allow a few minutes for the SeaQuest to adjust to the water temperature before calibrating the depth zero level.
- The float position affects the dive angle and towing depth, and needs to be determined experimentally for each new survey location and optimal towing depth. Always begin with a conservative position of the floats that produce only a very minor downward angle under tow, and monitor the depth and altitude carefully as towing begins, to prevent striking the bottom and causing damage to the platform and sensors.
- Never hoist the SeaQuest by its floats. Make sure the hoisting line does not wrap around or push against the floats. The float assembly is not designed to take the full weight of the SeaQuest frame when out of the water.
- Applying excessive load to either wings, floats, tail or sensor pods can lead to damage or deformation, which may adversely affect the towing characteristics, or cause damage to the sensors.
- Never allow the frame or sensor pods to swing out of control while hoisted, or hit any hard surfaces. This may lead to permanent damage to the sensors or frame.
- Note that the altimeter is located in the nose bulkhead, approximately 0.76m higher than the lowest point of the vertical wing. Be sure to account for this 'draft' when interpreting the altitude readings, to avoid striking the bottom with the keel sensor.

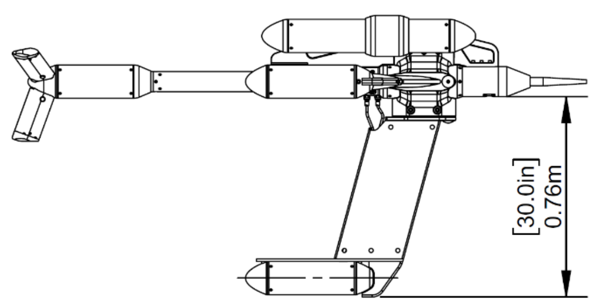


Figure 1-3 - Altimeter echo-sounder location relative to lowest point on the frame

Refer to the following sections for details on each of the auxiliary sensors and float positioning.

1.3 Performance Characteristics

The SeaQuest's most important characteristic is the superb absolute accuracy of its Overhauser sensors. A magnetic gradiometer must be able to reliably report an accurate zero-gradient to be useful. The only way this can be achieved is by having extremely accurate repeatability between sensors. The SeaQuest's Overhauser sensors are repeatable to better than 0.01nT, and they show zero detectable heading error.

Another important characteristic is platform stability. In order for the magnetic field readings to have meaning, a gradiometer must provide accurate spatial position data for its sensors. The SeaQuest incorporates an acoustic altimeter and pressure sensor to report its vertical position in the water column, and an accurate 3-axis gyro-compensated IMU to report pitch, roll and yaw angles of the frame. Most importantly, the platform is extremely hydro-dynamically stable, which minimizes the need for dynamic compensation for motion effects as long as the platform is towed at a depth unaffected by surface waves.

The SeaQuest provides a base noise spectral density of 0.01nT-RMS/rt-Hz per sensor. This translates to roughly 0.009nT/m noise in horizontal gradient, and 0.028nT/m noise in vertical gradient.

Relating noise levels to actual detectable changes requires us to define a threshold signal-to-noise ratio (SNR) that we can use to identify anomalies. Using a practical SNR of 10:1, the SeaQuest's practical magnetic gradient detection levels are 0.1nT/m horizontal and about 0.25nT/m vertical. This is an order of magnitude finer than the deviation one would see from gradiometers based on other technologies simply by rotating them in place, and measuring their heading error.

Although the SeaQuest features a superb sensitivity and extremely low intrinsic noise, it is important to take into account the local background noise present at and unique to each survey site, which can be significant, depending on the type of location and presence or proximity to man-made infrastructure.

1.4 Understanding the System Components

1.4.1 Overhauser total field sensors

Marine Magnetics supplies a separate document titled the *SeaSPY Technical Application Guide* containing an in-depth description of how the Overhauser sensors work as well as general guidelines for estimating the size of magnetic anomalies produced by a given amounts of ferrous iron. Marine Magnetics provides this document to anyone free of charge, so please contact us if you do not already have a copy.

All SeaQuest gradiometers are supplied with omnidirectional sensors that are completely isotropic with respect to magnetic field direction. The only restriction that must be observed is that ***SeaQuest2 must not be oriented vertically with the nose facing upwards***. This is a restriction with respect to the direction of gravity, not magnetic field.

The Overhauser sensor measures *magnetic flux density*, the unit for which is the Tesla (T). Magnetic flux density on the surface of the Earth typically varies between about 18μT to 70μT, depending on location. The flux density at any fixed location on the Earth's surface also varies with time of day, due to diurnal effects, which include influence from the Sun (mainly the interaction of the Sun's radiation with Earth's atmosphere, which is subject to regular and random changes), and movement of the Earth's molten interior.

One often speaks of a magnetometer as measuring magnetic field instead of flux density, since the two values are directly related given an environment of constant magnetic permeability (such as air or water). Some materials will distort the surrounding magnetic flux density by 'amplifying' or adding to the ambient magnetic field. Such objects are known as *paramagnetic*. Some materials (such as iron, nickel, cobalt and alloys containing these materials) exhibit this effect very strongly, and are known as *ferromagnetic*. Objects made from these materials are very easily detectable by a magnetometer. Most building materials, especially those used to build modern boats and ships, contain iron alloys and are therefore magnetic. Some stainless steels (austenitic alloys such as 316) are only weakly ferromagnetic, but will become more strongly magnetic if their microstructure is disturbed by annealing, welding, machining or severe stressing. In addition to ferrous construction materials, there is a number of naturally-occurring minerals (e.g. iron oxides) that can be strongly magnetic. Such minerals are commonly found in igneous and volcanic rocks, as well as pottery, and any accumulations of gravel and boulders derived from igneous rocks. Surveying in environments dominated by igneous or volcanic bedrock can present challenges to the data analyst, and requires especially careful control of survey altitude.

Carbonate-based rocks, on the other hand, do not contain any magnetic minerals, and areas dominated by limestone or sedimentary bedrock do not usually create a strongly-variable magnetic background, but tend to be affected by diurnal variation to a greater degree. For this reason the use of a base station magnetometer is especially recommended in non-magnetic bedrock environments.

When an object of high magnetic permeability distorts the flux density around it, it creates a magnetic gradient that is proportional to the magnitude of its permeability. If the magnetic gradient through the volume of the magnetometer sensor is too great, the sensor will not operate correctly. For this reason, massive magnetic objects must be kept away from the sensor. **Do not expect the magnetometer to produce good results on the deck of a ship, or inside a building, or next to a rocky outcrop containing igneous or volcanic rocks,** any more than you would expect a high-powered telescope to see distant stars in the middle of the day or through a dirty window.

For more information on magnetic fields and operation of the Overhauser magnetometers, please refer to the *SeaSPY Technical Application Guide*. This document can be obtained from Marine Magnetics.

1.4.2 Leak Detector

Each SeaQuest is equipped with a leak sensor that triggers a warning in BOB when water is present inside the electronics pod. The message "**WARNING! WATER DETECTED IN CENTER POD**" will also appear in the command window every 10 seconds. Even a small drop of water will activate the leak sensor. **In the event of a leak warning, the SeaQuest should be retrieved immediately, as it is very likely that a leak has developed in the electronics housing.** Water inside the electronics pod may damage the electronics module and Overhauser sensors.

1.4.3 Pressure Sensors

The standard SeaQuest pressure sensor is a Wheatstone bridge on a silicon diaphragm. The maximum pressure that this sensor can withstand before potentially suffering damage depends on the pressure rating of the housings. Exceeding the rated depth can cause a change in the calibration tuning of the sensor, and its accuracy may suffer as a result. The pressure sensor will not suffer serious mechanical damage (i.e. will not rupture and cause a leak) until exposed to twice its rated operating pressure.

Note that the SeaQuest2 housing is available with a single depth rating of 300m. Take care not to exceed this depth to prevent damage to the housing.

SeaQuest can interface seamlessly to a variety of other pressure sensors, suited for shallow or deep work. In general, a larger pressure sensor range will result in lower precision in the pressure reading.

Range (psi)	Range (m)	Precision	Installation
150	100	0.1 m	optional
500	345	0.1 m	**standard**

table 1-1: Pressure sensor options

The pressure sensor is an analog device that may drift with temperature and with time. For proper operation, the pressure sensor zero-level should be reset before every survey, after allowing the SeaQuest to adjust to the temperature of the water. For optimal results the platform should be submerged for several minutes to allow the temperature of the pressure sensor to reach the ambient water temperature. Following that, the pressure sensor zero-level can be calibrated at the surface or above water. The zero-level calibration can be done through BOB, or by sending a **p** (lower-case p) command via a serial terminal.

The **P** (upper-case P) command will display the current pressure range calibration settings, and will offer the option to set the full-scale pressure calibration. The full-scale calibration is factory-set, and does not need to be altered by the operator unless below-nominal full-scale accuracy is suspected. Unless specifically instructed to do so by Marine Magnetics technical support, **do not attempt to alter the pressure range calibration** as it requires full control of the water pressure and may adversely affect the accuracy of the sensor readings if done incorrectly.

Refer to Section 6 (page 26) for details on the command interface.

1.4.4 Altimeter echo sounder

A 200kHz narrow-beam echo sounder is located on the bottom of the nose bulkhead. This device senses the distance from the face of the transducer to the sea floor by emitting 10 sound pulses per second, and providing these altitude readings to the SeaQuest electronics. Note that the bottom of the SeaQuest vertical wing will be closer to the sea floor than the transducer, so be careful to ensure that the bottom wing does strike the sea floor or any obstructions that may cause physical damage to the frame of sensors.

The SeaQuest altimeter has a range of 0.5m to 90m, and a resolution of 0.01m. To see the current altitude of the platform, use the **d** command. Altitude is displayed in meters as ‘A005.00m’. In addition, an altitude reading is included in every magnetic field reading to allow real-time monitoring. Note that the altitude data field does not appear if the altimeter is not installed in the platform.

The altimeter does not work when out of the water, and will display a value of 599m, representing an out-of-range condition. This indicates that the altimeter cannot ‘find’ a surface underneath the platform, but otherwise working properly. If the altimeter were to stop working, the altitude reading would disappear from the data stream completely.

1.4.5 IMU (Inertial Measurement Unit)

The SeaQuest is equipped with a 3-axis IMU containing a 3-axis gyro that provides very accurate measurements of the pitch, roll and yaw attitude angles of the SeaQuest frame. The yaw angle (+/- 180) is converted to heading (0-360) automatically by the SeaQuest2 electronics.

Although the platform orientation does not impact the operation of the sensors, or the value of the Total Magnetic Gradient, it is important to keep in mind that it does impact individual gradient measurements if one were to study and interpret those individually. (e.g. with a pitch angle of 45 degrees, the vertical gradient is no longer vertical, etc.)

If you observe a regular rhythmic oscillation in the vertical gradient when under tow, it could be that the SeaQuest is not deep enough below the surface waves, causing it to move unevenly through the water.

IMU readings are added at the end of each magnetic field data string as p00.0, r00.0, h00.0, and can be monitored in real time using the Attitude Indicator tool in BOB, or in graph form on the BOB Profile Plot. Please refer to the BOB User Manual for details.

The pitch, roll and heading (yaw) angles use the following sign convention:

pitch	Positive direction with nose downward: Range: +/-179.9
roll	Positive direction with starboard side down. Range: +/-179.9
heading	Positive counter-clockwise from magnetic north. Range: 0 - 359

Table 1-2 - IMU attitude angle sign convention

The IMU is factory calibrated prior to shipment and does not require user calibration. However, a small deviation of the heading angle from the true magnetic north direction may be observed in some situations.

To see a high-frequency IMU data feed, use the **m** command in the terminal. Refer to Section 6 (page 26) for details on the command interface.

1.4.6 Electronics Module / Pod

The SeaQuest electronics module is the core of the SeaQuest system, located in the center of the frame. It controls all of the sensors in the platform, monitors their performance, and reports their data to the host acquisition device digitally over the tow cable connection. Interface to the electronics module is through a single two-wire connection, which has DC Power and telemetry multiplexed into it.

All SeaQuest electronics modules are completely interchangeable. The only difference between them is a 16-bit serial number that is stored in non-volatile RAM within the unit.

The SeaQuest2 should never be submerged unless all sensor cables are plugged in.

The electronics pod is not fully pressure-sealed unless all sensor cables are plugged into it. The protective dust caps for connectors and tubes do not offer protection against water pressure.

1.4.7 Frame

The SeaQuest2 frame is a rigid streamlined structure consisting of two wings, one keel, and one tail boom, all connected to a central core. The wings and keel feature the same streamlined design of rigid hard-anodized aluminum that provides strength and rigidity. Sacrificial anodes are attached to aluminum parts to reduce corrosion. The keel and wings are identical, except for their weight – the keel is made to be heavier. The keel can be identified by a distinct color of surface anodizing, as well as additional drainage hole near the sensor pod.

Four Overhauser sensors are mounted in pods at the tips of the horizontal and vertical wings, as well the tail boom.

The central core contains the electronics module, which also includes the IMU, pressure sensor and altimeter electronics.

The nose contains a brass tow connector that is designed to bear the entire load of the tow system in addition to providing a two-conductor electrical connection. Note that the shell of the connector is AC-coupled to the system ground, and is connected electrically to the water, providing a sea ground.

The pressure housings for Overhauser sensors and the electronics pod consist of a filament-wound fiberglass cylinder coated with polyurethane for abrasion and shock resistance.

SeaQuest2 is available in one single depth rating: 300m.

Only completely non-magnetic materials are used in the entire SeaQuest assembly, including all fasteners and components. This is to ensure a zero heading shift and to eliminate any sources of magnetic interference and guarantee the excellent signal quality and low noise characteristics of the SeaQuest.

Should any of the fasteners require replacement, be sure to request the appropriate original fasteners from Marine Magnetics, which are made from specific materials such as naval brass and titanium. Do not attempt to replace the fasteners with anything else.

For a list of O-ring sizes in the housing seals, refer to Section 3.3 (page 16).

1.4.8 Isolation Transceiver

The SeaQuest2 Isolation Transceiver consists of power-conditioning electronics that supplies clean constant power to the SeaQuest, as well as a microprocessor to bridge the communication between the SeaQuest's FSK protocol and the PC's RS232 interface. Power and RS232 are both fully isolated from the supply ground, providing extremely high immunity to noisy power supplies at all frequencies. The wide input range of +9VDC to +28VDC allows for operation with both 12VDC and 24VDC lead acid batteries. Internal regulators produce a constant +48VDC to power the SeaQuest. The power and communication to the SeaQuest are multiplexed together for use with a two-conductor cable. This hardware is sealed in a rugged housing that is splash proof, but not waterproof.

The transceiver also supports USB for use with computers that do not have a standard serial port. For more information on how to connect the transceiver, refer to Section 2(page 12).

An Isolation Transceiver is able to communicate with a SeaQuest platform across up to 10,000m (32,808ft) of the standard SeaQuest twisted-pair tow cable.

A new generation Isolation Transceiver is available as of 2022, which includes a GPS input connector. This allows the boat-mounted GPS to be connected directly to the Transceiver through a Y-adapter, in addition to being connected to the PC. This allows the Transceiver to use the NMEA UTC time and date for perfect time synchronization between the GPS positions and magnetometer readings.

1.4.9 AC Power Supply

In most cases, electrical power to the SeaQuest towfish will be supplied by the Isolation Transceiver, which produces a clean, constant +48VDC to power the unit. The input range for the Isolation Transceiver is +9 to +28VDC.
If the Isolation Transceiver isn't used in the deployment, power conditioning should be as follows:

- SeaQuest requires DC power with a range of +30V to +50V
- For long tow cables (longer than 300m) it is recommended to keep the supply voltage above +35V
- It is always recommended to keep the supply voltage as close to the upper limit as possible in order to compensate for the voltage drop in the tow cable
- The maximum power consumed by the towfish is approximately 20W when acquiring data (including the altimeter), and is typically around 8W when in standby. The Isolation Transceiver consumes an additional 2W.

The standard SeaQuest AC power powers the Isolation Transceiver with 24VDC output, and can accept any input AC power from 100 to 240VAC, at 50/60Hz offering worldwide compatibility.

Note that the AC power supply uses a 3-prong North American style plug. **It is extremely important that the third (middle) prong from this plug is connected to a proper ground, boat hull or sea ground**. Without a good ground connection, you may experience communication problems, or even a degradation of magnetometer performance.

Battery Clip Cable (Optional) is an alternative method for powering the Isolation Transceiver, and can be connected to any 12V or 24V battery. 24V is recommended for gradiometers.

Note that the voltage of a typical 12VDC lead-acid battery will vary from approximately 14VDC when fully charged to approximately 9VDC when nearly discharged. A 24VDC lead-acid battery set will provide a range of 18 to 28VDC going to the SeaQuest system over the full charge cycle of the battery set.

The SeaQuest Isolation Transceiver contains protection against polarity reversal. Therefore, connecting the black clip to the positive terminal, and the red clip to the negative terminal will cause no damage. **However, no protection exists against over-voltage. Use caution not to connect the battery clips to any voltage higher than 28V**.

1.4.10 Tow Cable

The standard SeaQuest tow cable (yellow in color) is a shielded twisted pair (two conductors plus shield) with a high strength, lightweight braided Vectran strength member. The tow cable can withstand loads of up to 1000lb without any damage, and loads of up to 6000lb without breaking. It is sheathed in a tough polyurethane jacket and is fully water blocked. This means that if the jacket is cut or damaged, water migration through the tow cable will be greatly slowed, but not completely stopped depending on the external pressure. A damaged cable jacket should be repaired as soon as possible.

The two conductors in the tow cable carry both the DC power and the telemetry signals, for powering and communicating with the SeaQuest. The red conductor carries the positive voltage and telemetry, and the black conductor carries the negative voltage and common ground. The outer braid is only used to shield the inner two wires from external noise, not to carry electric current. It is connected to the cable's negative conductor at the source (topside) end of the cable only.

1.4.11 Deck Cable

The deck leader cable is designed to connect the main tow cable spool, which is usually left on the deck of the deployment vessel near the stern, to the Isolation Transceiver, which is normally kept in a controlled interior environment. The deck cable's jacket is very tough polyurethane that is designed to withstand rain, extreme abrasion and crushing, but is not designed to withstand towing force.

1.4.12 USB Cable

The USB cable connects the Isolation Transceiver to your PC. It is a gray cable with one USB connector that plugs into the PC, and one female 8-pin circular connector that connects to the Isolation Transceiver.
This cable is useful for laptops or computers that do not have a standard serial port. The Isolation Transceiver contains a built-in RS232-USB adapter, which acts as a virtual COM port on the computer. The USB driver for this adapter is supplied with BOB software. Please note that this virtual COM port is available only when the transceiver is powered.

1.4.13 RS232 Cable - Optional

The RS232 cable is an optional replacement for the USB cable. It is a gray cable with one female 9-pin DSUB connector that plugs into the serial port of your PC, and one female 8-pin circular connector that connects to the Isolation Transceiver. An RS232-USB adapter (commercially available) can be used for computers lacking a serial port. Unlike the USB cable, using an external RS232-USB adapter makes the virtual COM port available even when the transceiver is not powered.

1.4.14 Adjustable Floats

SeaQuest2 has two floats above the electronics pod, which can be adjusted by sliding them forward of aft.

This allows the user to change the center of buoyancy of the entire frame, and change the pitch angle of the wings. Moving the floats forward will reduce the pitch angle, and allow the SeaQuest to remain at or near the surface when under tow. Moving the floats aft will increase the pitch angle, and force the SeaQuest2 to dive when under tow.

The float position needs to be determined experimentally for each new survey location and desired towing depth, as it depends on the towing velocity and the pitch angle of the frame, and the optimal towing depth for each specific survey.

Always begin with a conservative position of the floats that allows the SeaQuest2 to remain close to the surface, which exposes approximately 7” of the forward end of the float. Try towing and observe the behavior.

Refer to Section 3.4.4 (page 19) for details on float adjustment.

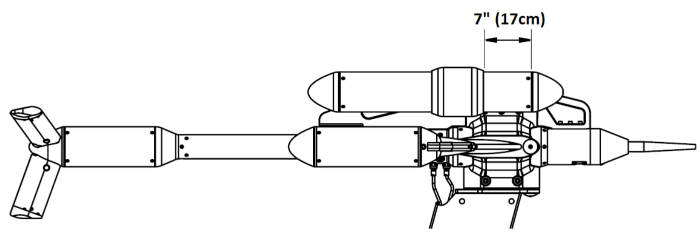
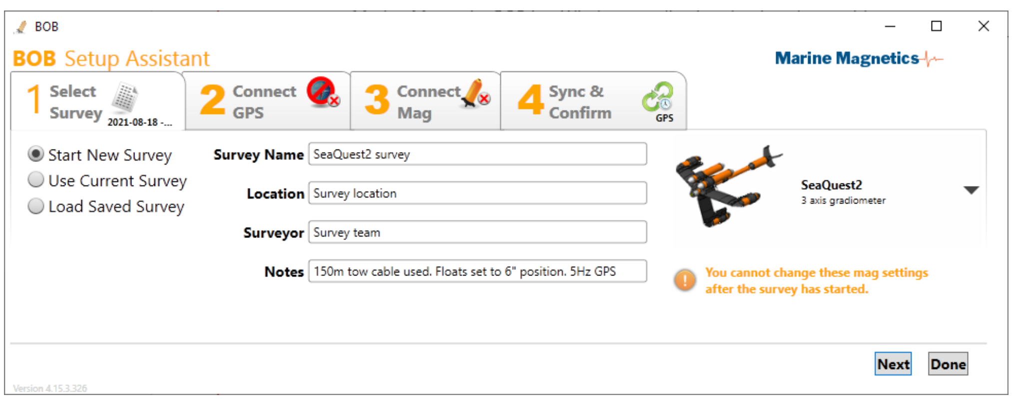


Figure 1-4 - Default position of the floats

1.4.15 BOB Software

Marine Magnetics BOB is a Windows application that interfaces with your magnetometer, to allow full control over the towfish, data collection, survey planning and data visualization. For detailed information on using this program refer to the *BOB Operation Manual*. Visit: https://bob.marinemagnetics.com/



2 Communication via the Isolation Transceiver

By default, all communication with the SeaQuest is via the Isolation Transceiver, which inserts an intelligent layer between data logging software and the towfish. The transceiver assumes complete control over the tow cable communication link, and time synchronization with the GPS, as well as supplies optimal power to the towfish for a wide variety of cable lengths and specifications.

2.1 Transceiver Serial interface

The connection between the data logging computer and the Transceiver is via RS232 interface, using:

- 115200 baud
- 8 data bits
- No parity
- 1 stop bit

Communication is full-duplex. Any commands that are sent to the SeaQuest while it is transmitting will not disrupt the transmission.

When using the supplied USB cable, the transceiver's integrated RS232-USB converter is used, which emulates a virtual COM port with the same settings.

When you send a command to transceiver, you may get a response even if there is no SeaQuest connected. For example, you can query and set the transceiver's internal time and date without the SeaQuest connected. As soon as you connect the SeaQuest, the transceiver will recognize the SeaQuest, and set its time as necessary.

Refer to Section 6 (page 26) for details on the command interface.

2.2 Transceiver Internal Real-Time Clock

The Isolation Transceiver contains a real-time clock that it used to synchronize the clock inside the SeaQuest during the survey. The transceiver real-time clock continues running when power is disconnected. The clock is powered by an internal lithium battery that automatically recharges when power is applied to the transceiver. The clock will keep time accurate to 0.65 seconds per day in ambient temperatures of –40 to +85˚C, or accurate to 0.15 seconds per day in ambient temperatures of 0 to +40˚C.

Note that after an extended storage period between surveys (several weeks), the internal real-time clock battery may discharge and the clock will reset to zero. For this reason, it is recommended to "charge" the transceiver for at least 6 hours prior to the survey following an extended period of storage. This will ensure that the real-time clock battery will be sufficiently charged to ignore any power cycles that may occur during the survey.

2.3 Transceiver Output Voltage

Standard isolation transceiver units are built to output +48VDC to the SeaQuest tow cable, using input voltages of +9 to +28VDC. Power and RS232 are both fully isolated from the supply ground, providing extremely high immunity to noisy power supplies at all frequencies.

Note that all isolation transceiver units use a 1.0A resettable input fuse. If your input voltage is too low, the transceiver will have to draw more current to supply the same power to the SeaQuest tow system. For this reason a 24V input source is recommended for most situations.

The resettable fuse has a variable trip delay based on the amount of over-current. For example, if the transceiver is drawing 1200mA, you may find that the SeaQuest system will work well for a short while, and then trip the fuse for no apparent reason. If your transceiver seems to 'go dead,' it is possible that you have simply tripped the fuse due to input voltage being too low. Simply power down the system, wait a few seconds, and then turn it on again.

You can monitor the transceiver input and output voltages and currents at any time using the **d** command. Refer to Section 6 (page 26) for details on the command interface.

2.4 Transceiver Status LEDs

The Isolation Transceiver has two status LEDs, one for power and one for communication. The LED modes indicate the following states:

Power LED	Orange	SeaQuest not connected/maidetected.
	Green	SeaQuest is detected and powered.
	Red	Fault condition. Or Transceiver disabled power to towfish.
Communications LED	Blue (flashing)	Data is being transmitted.

Table 2-1 - LED indicators on the Isolation Transceiver

3 Assembling the SeaQuest2 Platform

3.1 SeaQuest2 Components

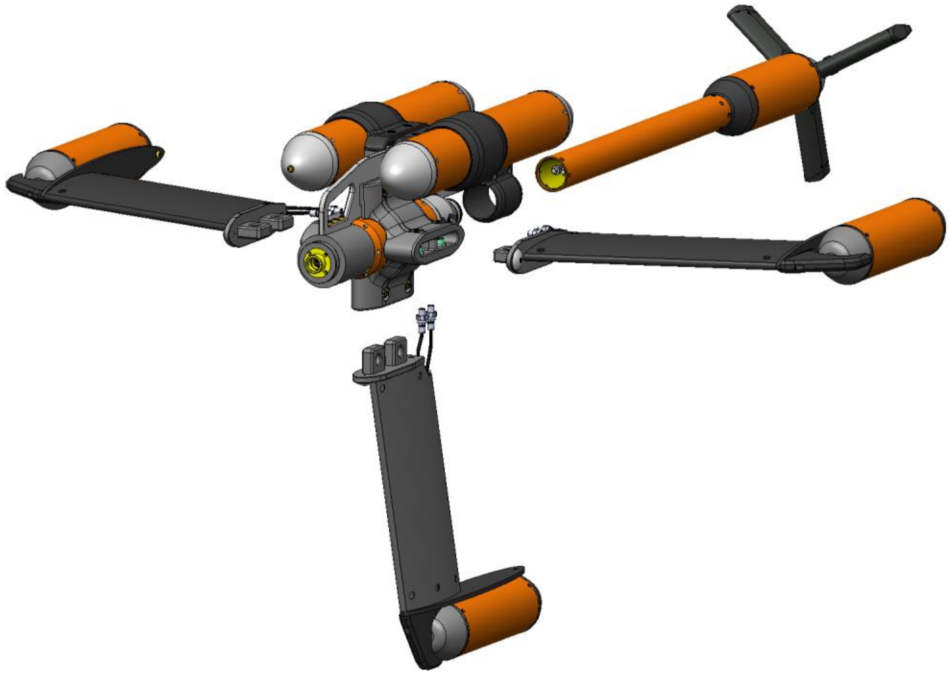
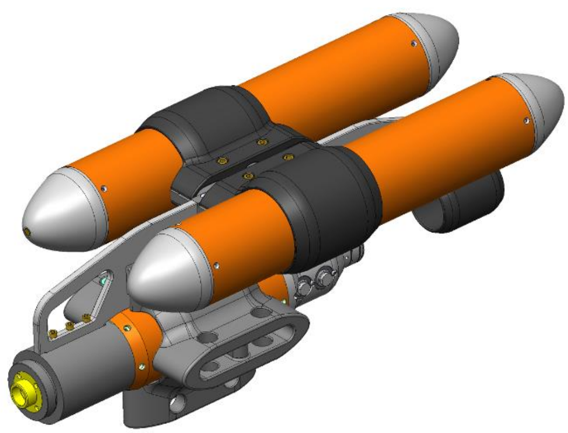
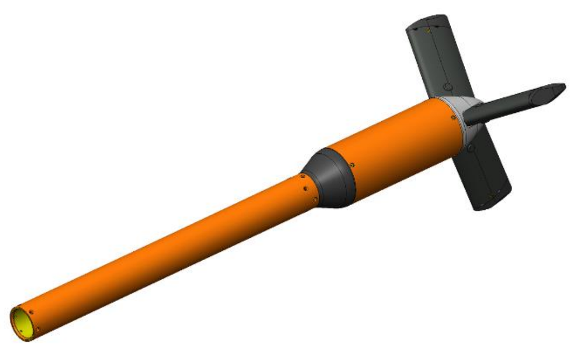


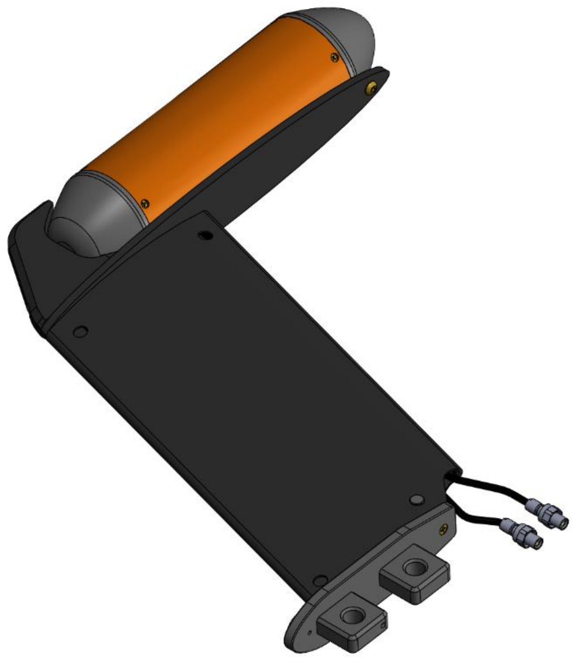
Figure 3-1 - SeaQuest2 assembly showing individual components



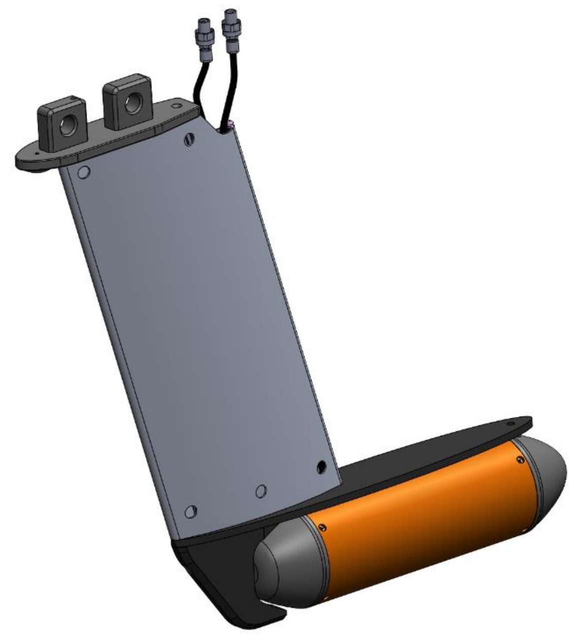
Core with the electronics pod and floats



Tail with sensor pod and stabilizer fins.
Note the correct orientation, for optimal stability when under tow

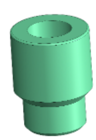


Two wings with sensor pods



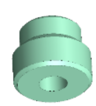
Keel with sensor pod
Note the distinct color of anodizing, and an additional drainage hole on the keel

Hardware required for assembly:



Wing anchor bushing – Long

x6



Wing anchor bushing – Short

x6

Wing anchor bolt (socket head)

x6

Tail tube screw

(Phillips)

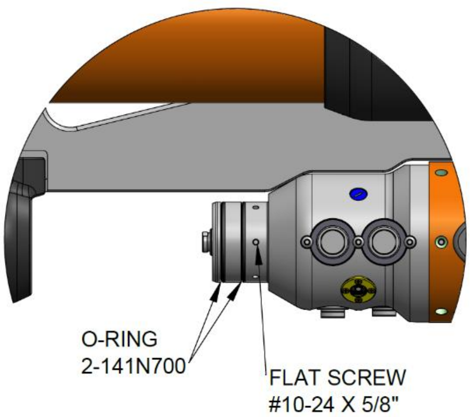
x6

All hardware must be completely non-magnetic to ensure correct operation of the SeaQuest. Contact Marine Magnetics for spare parts whenever necessary.

3.2 Tools

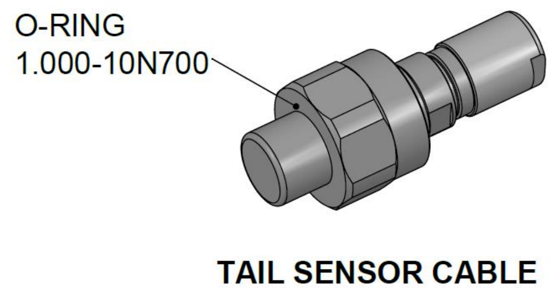
- 3/16” hex Allen wrench (for tail section clamp)
- Phillips screwdriver (for tail section tube flange)
- 5/16” hex Allen wrench (for wings and float assembly)
- 11/16” socket wrench (for wings)

3.3 Fastener and O-ring sizes. Spare parts



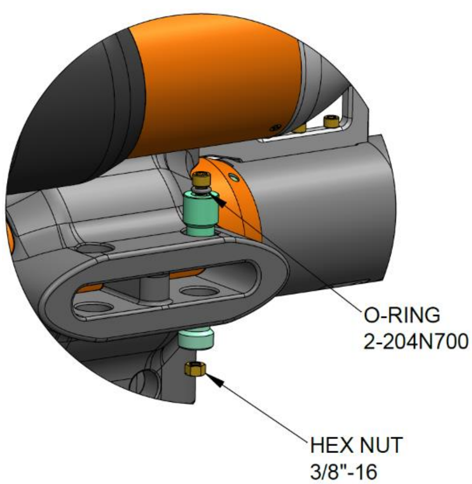
Tail connection detail

O-ring and screw sizes



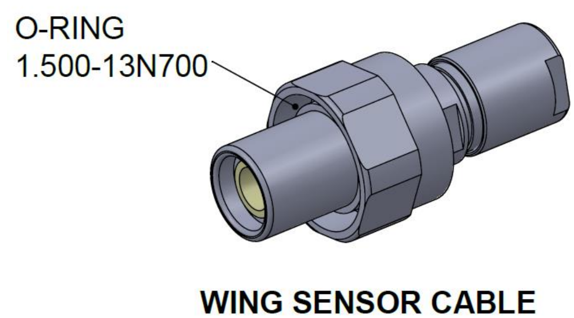
Tail sensor cable connector

O-ring size



Wing fastener detail

O-ring and screw sizes



Wing sensor cable connector

O-ring size

3.4 Assembly Instructions

3.4.1 General assembly precautions

Always ensure you have a clean surface to work on, free of debris and sand, to prevent contaminating the seals on the tail tube flange, and inside the sensor cable connectors.

Sand is highly-abrasive, and often magnetic. Getting sand into any part of the frame could compromise the water seals, and introduce a source of magnetic noise.

If any debris is present on the seals or seal surfaces, wipe all the mating surfaces with a lint-free cloth, and apply extra silicone lubricant. Replace the O-ring seals if you see any signs of damage on the rubber.

Never allow water to get into the sensor cable connectors. If necessary, blow the water out with compressed air, or wait for it to dry. Presence of water inside the coaxial sensor connector may compromise the sensor signals and result in poor sensor performance, or damage to the electronics.

3.4.2 Tail assembly procedure

- Place the core module upside-down on a clean flat surface free of abrasives
- Fit the tail section through the clamp at the rear of the core
- Fasten the electrical connectors – hand-tight only! Observe the color coding.
- Slide the tail tube over the lubricated O-ring seals
- Carefully align the screw openings with the corresponding threaded holes on the core flange
- Carefully thread the flange screws in. To prevent cross-threading, always start turning the screw counter-clockwise first, until you feel the screw “click” into the start of the thread, and then proceed to turn it clock-wise.
- Do not overtighten flange screws to prevent damage to the core flange threads. The water seal is ensured by the O-rings, not the screws!

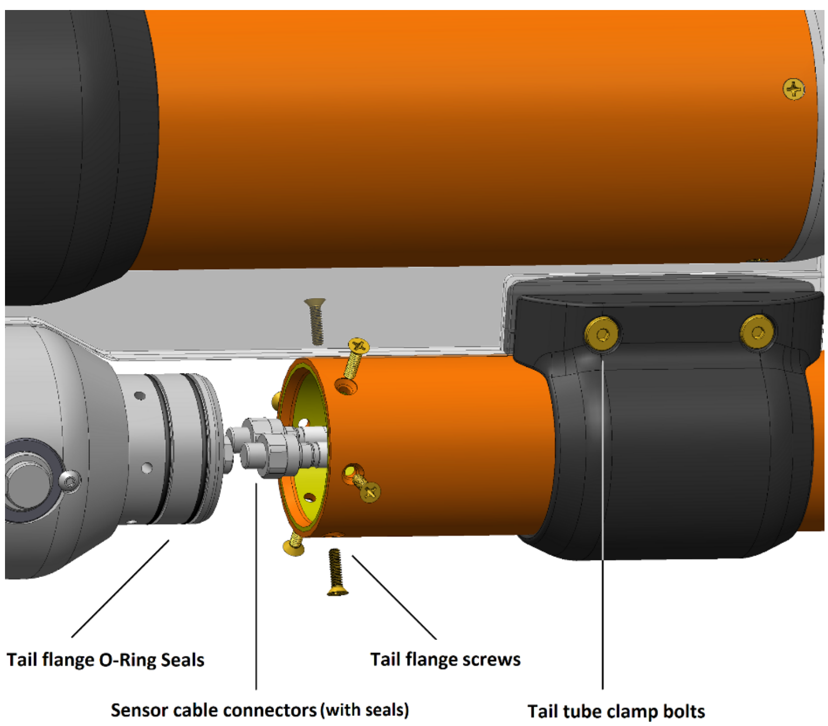


Figure 3-2 - Tail attachment detailed view

3.4.3 Wing assembly procedure

The keel and wings are identical except for their weight in water: the keel is made to be heavier in water to help maintain the SeaQuest2 stability and horizontality when under tow.

Both the wings and the keel contain openings for water drainage. Do not allow sand or debris to accumulate inside the wings, as it may lead to magnetic interference or corrosion.

Always inspect all sensor cable connectors, on both the wings and the core, for signs of debris, water, or damage to the o-ring seals. The sensor connectors rely on the o-ring seals to remain waterproof.

Water ingress into the sensor connector can lead to compromised sensor performance, or damage to the electronics.

Never insert your fingers into the openings where bushings are installed: this can cause personal injury! When necessary, use a tool to remove a bushing that is stuck inside the quad-clamp.

- Place the core and tail assembly on a clean flat surface free of abrasives
- Fit one of the horizontal wings into the core quad-clamp
- Insert the long bushings to hold the wing inside the clamp
- Insert the wing bolts with bolt o-rings into the bushings (The bolt o-rings provide a locking function)
- Insert the short wing bushings from the other side
- Secure with nuts, using the 11/16” wrench provided
- Connect the sensor cables to the core connectors observing the color coding
- Hand-tighten the sensor cable connectors
- Repeat for the opposite wing and the keel

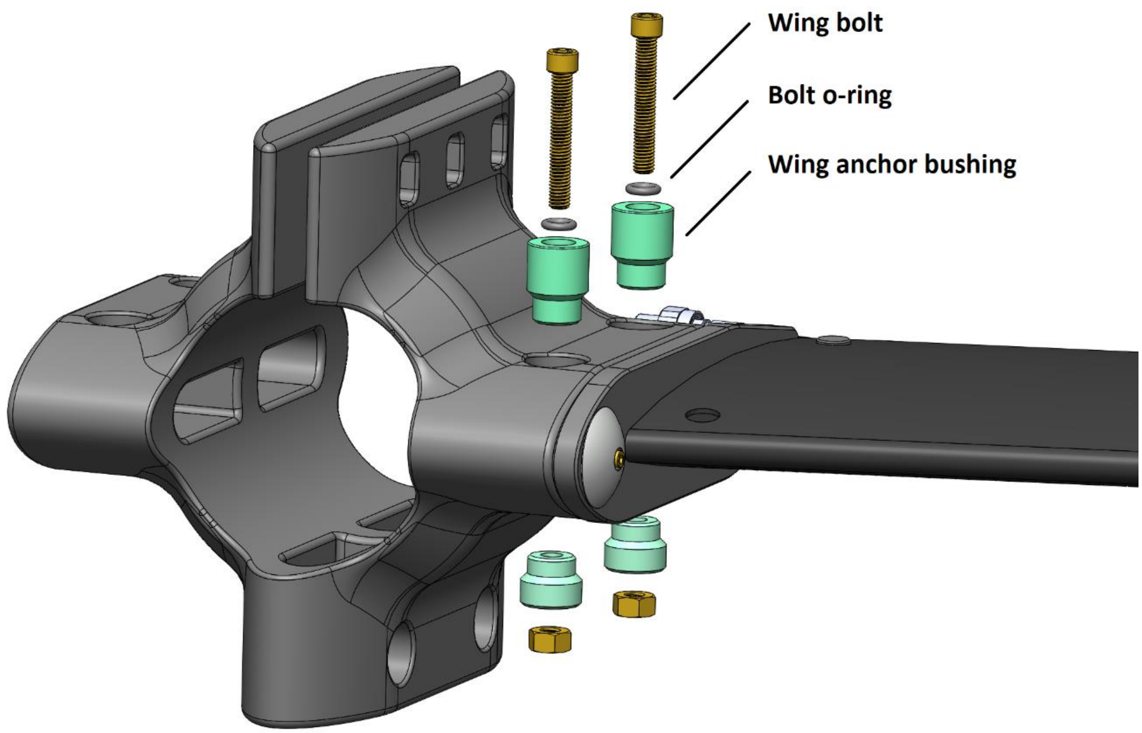
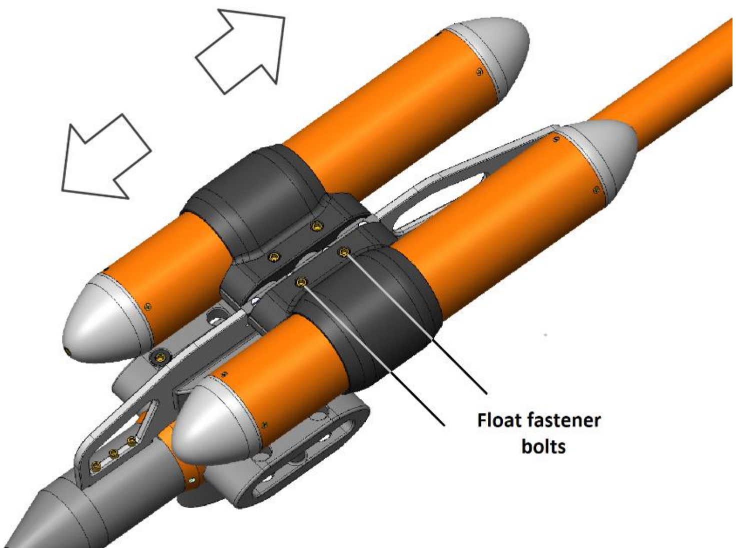


Figure 3-3 – Wing attachment detailed view

3.4.4 Float adjustment procedure

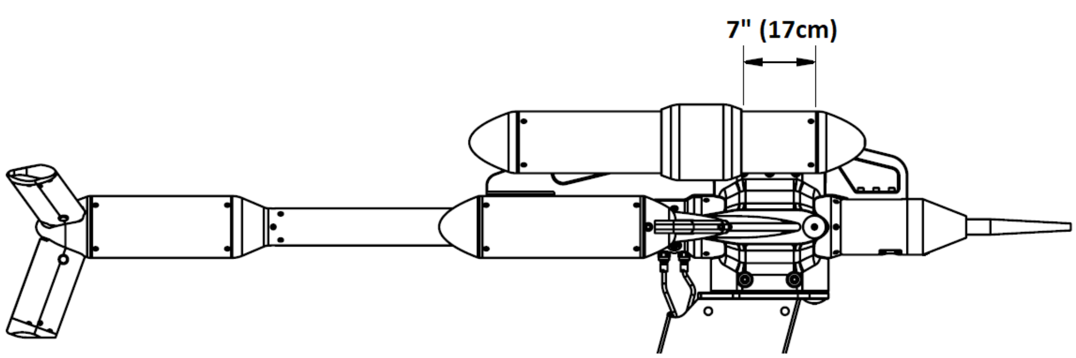
The floats can be adjusted forward or aft, as needed, to move the center of buoyancy of the entire frame and set the desired pitch angle for controlling the towing depth.

To adjust the floats, loosen the fastener bolts on the float clamps just enough to be able to slide the floats forward or aft.



The float position needs to be determined experimentally for each new survey setting and desired towing depth, because it depends on the towing velocity, pitch angle of the frame, and the optimal towing depth for each specific survey.

Always begin with a conservative position of the floats that allows the SeaQuest2 to remain close to the surface, which exposes approximately 7” (17 cm) of the forward end of the float.



Try towing and observe the behavior. Then begin making minor adjustments, moving floats aft in increments of 1”, to increase the downward angle. After each adjustment, try towing while monitoring the depth and altitude carefully as towing begins, to prevent striking the bottom and causing damage to the platform and sensors. TIGHTEN THE TWO SCREWS ON EACH CLAMP SUFFICIENTLY TO KEEP THE FLOAT TUBES FROM MOVING, USING THE 5/16” ALLEN KEY TOOL PROVIDED.

Once the optimal float position has been determined, note the length of exposed float and the survey can continue.

4 Connecting the Equipment

The following diagram shows how to properly connect the SeaQuest2 system. If you are using a side scan sonar with your magnetometer, refer to Section 8 (page 32) for further instructions.

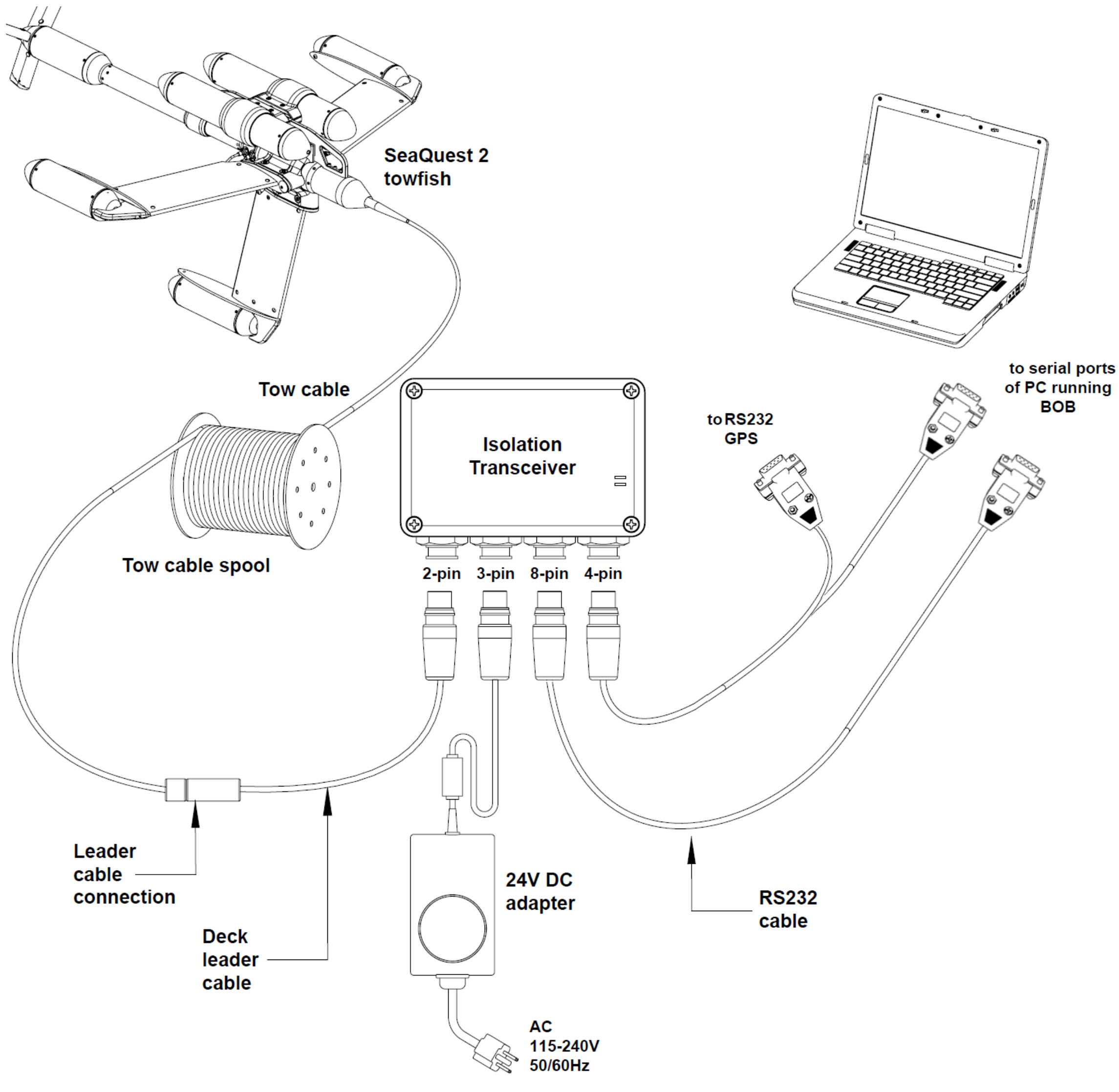


Figure 4-1 – SeaQuest2 system connection diagram

Connect the Isolation Transceiver to a PC or other type of host computer using either the USB or the RS232 cable provided with the system. Plug the circular 8-pin female connector into the transceiver and the female DB9 connector into the serial port of the PC. If your PC does not have an available serial port, you can use either a USB to Serial converter or the transceiver USB cable.

If you are powering your unit from an AC power source, plug the circular 3-pin female connector end of the AC adapter into the transceiver and then plug the power cable into 100-240VAC, 50/60 Hz. The unit can also be powered from a DC source using the optional *Battery Clip Cable* by connecting the two large alligator clips to the battery terminals and the circular 3-pin female connector to the transceiver. Refer to Section 1.4.8 (page 9) for further details on the Isolation Transceiver.

The deck leader is a long black cable (typically 20 to 30 feet) that connects the transceiver to the main tow cable. Plug the circular 2-pin male connector end into the transceiver and then plug the coax connector on the other end into the main tow cable of the system. Note that the deck leader is not designed for underwater use, although its connectors are sealed. In addition, no towing stress should be placed on the deck leader.

The tow cable must be firmly secured to the towing vessel. On larger vessels, this is sometimes done by winding the tow cable on a secured winch, and connecting the deck leader to the slip ring connection on the winch. The deck leader then provides a connection between the winch and the transceiver, which is typically in an enclosed area close to the data acquisition equipment.

4.1 Main Tow Connector

The main tow connector provides the electrical connections to the towfish, and also bears the load of the platform as it is towed through the water. It is a rugged, heavy-duty connector that is able to withstand a great deal of physical punishment.

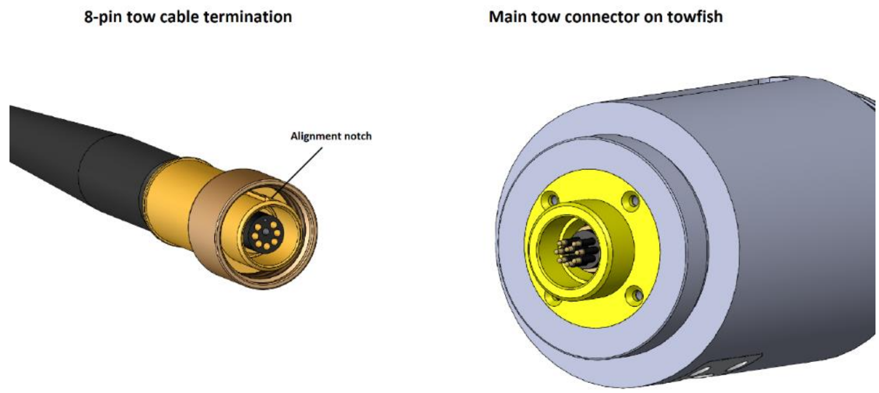


Figure 4-2 - Main tow connector

The cable connector has a locking slot that fits into a groove in the towfish side. When assembling the connector, line up the slot with the groove, and insert. The male connector should slide in all the way up to the locking ridge. Use the brass locking nut to fasten the connector in place. Do not be afraid of over-tightening this nut. It is too strong to be damaged by hands alone.

When the connector is assembled, no part of the thread on the towfish should still be visible. If it is, the nut has not been tightened fully, or the slot was not inserted properly in the groove. Also, if you can still rotate the bend restrictor after the connector has been assembled, the slot was not inserted properly in the groove.

When the tow connector is fastened, screw on the nose cone over top. The nose cone protects the tow connector from side impact, and provides secondary protection against being loosened while deployed.

The most important feature of the tow connector is that all parts are fixed in place when it is fastened – no part moves against any other part. If you have used shackle connections on other marine instruments in the past, you will notice a great benefit to the ruggedness and longevity of the SeaQuest2 connection system. Keeping the connector in operational order requires very little effort. Refer to Section 9 (page 34) for maintenance tips.

Note: The brass locking nut assembly is not DC grounded, but is AC grounded through a capacitor connected to the ground connector.

5 Deployment

5.1 Recommended deployment sequence

The following sequence of steps is recommended when deploying the SeaQuest2:

- Connect all the equipment with the SeaQuest2 still on deck of the vessel
- Power up the system and verify that the communication works properly
- If the ambient temperature is similar to the water temperature at the desired survey depth, then you may set the zero level of the pressure sensor at this point (by sending the **p** command). Refer to Section 5.3 (page 23) for further details.
- If the optimal float position has not been determined yet, set the float position to the default 7”(17cm). This can be adjusted later after the initial towing trial.
- Hoist the SeaQuest overboard using a crane or davit
- Verify that the SeaQuest remains afloat at the surface while the vessel is stationary
- Check that the communication works properly. Enable auto-tuning if it isn’t already enabled
- Begin towing at a slow speed
- Begin data collection, and observe the platform depth and altitude
- If the SeaQuest remains near the surface when under tow, the float position may need to be adjusted further aft

5.2 Checking connectivity and communication

When the transceiver is first powered up, the *Power* LED will glow orange and it will transmit a brief identification message to the PC. If a SeaQuest is detected, then the LED will turn green and the SeaQuest’s own identification header will also be displayed. You will notice the *Comm* LED will flicker blue as data is transmitted between the SeaQuest and the transceiver. Upon detection of the towfish, the transceiver will automatically set the towfish time.

A good way to start is by checking battery voltage at the magnetometer with the **d** command. The **d** command provides important information about the status of both the transceiver and the SeaQuest. The first line of data comes from the transceiver and represents the voltage, current and power being outputted to the platform. The second line of data comes from the SeaQuest and reports the status of three important sensors as well as the voltage at the towfish end of the tow cable. The first column shows the battery voltage. The voltage should be at least +30VDC. If it is lower, communication may be erratic, and the magnetometer may not operate properly. The voltage drop between the transceiver and the fish will depend on the length of your tow cable. The second and third columns display the depth and altitude of the platform in meters, while the fourth column shows the signal strength for the altitude reading. The next three columns describe the orientation of the platform (pitch, roll and heading). If a GPS Integration is connected.

5.3 Setting pressure sensor zero-depth level

Prior to each survey, it is a good idea to zero the depth sensor. In moderate climates this can be done on the deck of the vessel when the SeaQuest has already cooled or warmed to the ambient air temperature, since the output of the depth sensor will vary slightly with temperature.

If the water temperature is significantly different from the air temperature, the SeaQuest may need to be immersed in water for 5-10 minutes to allow it to adjust to the water temperature, before the pressure sensor zero-depth level can be set (after raising the SeaQuest back to or above the surface). This will ensure the most accurate depth readings during survey.

Zero the depth sensor with the **p** (lower-case p) command. You will be prompted for confirmation before the sensor is zeroed.
The scale of the depth sensor can be set using the **P** (capital P) command. **You should not change this unless you**

suspect the accuracy of the depth measurement. For more information on the pressure sensor, refer to Section 1.4.3 (page 7).

5.4 Hoisting Points

The vessel should be stationary when deploying the SeaQuest. The floats allow the SeaQuest to remain afloat while stationary, which simplifies the deployment and retrieval, allowing the hoisting line and bridle to be disconnected from the frame in a controlled manner before the vessel is underway.

It is recommended that at least 2 people handle the SeaQuest during deployment and retrieval, to prevent damage to the frame and sensors.

Two large openings are provided in the rigid aluminum center plate, one near the nose, and another near the tail. These can be used as handles, or hoisting points when lifting the frame.

To prevent damage to the corrosion-resistant anodized finish, use a rope or sling bridle through the hoisting openings, and avoid direct contact between the metal hoisting hardware and the aluminum frame.

Never hoist the SeaQuest by its floats. Make sure the hoisting line does not wrap around or push against the floats. The float assembly is not designed to take the full weight of the SeaQuest frame when out of the water.

Never allow the frame or sensor pods to swing out of control while hoisted, or hit any hard surfaces.

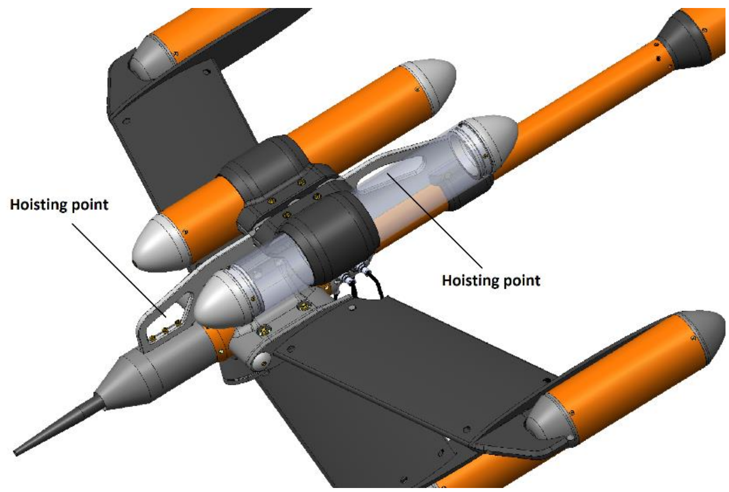


Figure 5-1 - SeaQuest2 hoisting points

5.5 Deploying the Platform

The vessel should be stationary when deploying the SeaQuest.

Once the platform is in the water, have the captain begin a straight line course at a very slow speed (<2kts). Disconnect the platform from the crane and slowly pay out the tow cable. SeaQuest may plane on its wings as you let out the first 10m or so of cable. Be sure to record how much tow cable you let out.

Once the platform is **completely** submerged, monitor the depth, altitude and pitch angle of the platform using the SeaQuest data acquisition software. **Note that SeaQuest must be completely submerged for proper operation.**

Have the captain accelerate to the desired survey speed (e.g. 4 kts) and continue to slowly deploy the tow cable, while monitoring the depth and altitude of the platform.

If the depth begins increasing rapidly when under tow, and there is a risk of striking bottom, the floats may need to be adjusted forward.
Follow the instructions in Section 3.4.4 (page 19) to adjust the position of the floats to achieve the desired platform pitch and depth. Note that positioning the floats forward will cause the platform to pitch upwards, keeping the SeaQuest close to the surface. Positioning the floats farther aft has the effect of pitching the platform downwards, causing the SeaQuest to dive.

Once a suitable towing distance and platform altitude are achieved, secure the cable at the ship's tow point. Recommended towing altitude for most applications is 4-8m.

5.6 Begin data collection

To start collecting data, initiate sampling at the desired sampling rate using commands **1** through **4**. Selecting **1** will choose the fastest cycling rate of 0.25 seconds per reading, and **4** will select the slowest of 5 seconds per reading. A rate of 2 readings per second (**2** command) is most commonly used.

Note that sensitivity may drop slightly at faster sampling rates. The maximum sensitivity of 15pT RMS is retained at rates up to 1Hz. Sensitivity drops to 50pT RMS at 2Hz, and 100pT RMS at 4Hz.

If the auto-tuning feature is enabled (as is recommended), the first reading taken after power-up will initialize the instrument tuning, and will take just under three seconds. The instrument's tuning will track changes in magnetic field as time progresses. If the instrument determines later in its operation that it has become mistuned (an occurrence seen only in magnetically noisy environments), a tuning initialization procedure will commence automatically. If the auto-tuning feature is disabled, and tuning is fixed, the instrument will cycle at the programmed rate, regardless of whether it becomes mistuned or not. Keep in mind that if the unit is not properly tuned, signal quality will suffer. For this reason, it is recommended to keep auto-tuning enabled in normal operation.

Before you begin surveying, **the platform must be deployed back a distance equal to at least 3 times the length of your vessel**. **Failure to do so may compromise the quality of the recorded data due to magnetic interference from the survey vessel.**

6 SeaQuest Commands

Interaction with the SeaQuest system is done using single-character commands. These commands can be sent by the SeaQuest software by typing in the terminal window or by selecting a menu option using the COMMAND menu. Normal operating commands are outlined in the following table.

6.1 Normal Commands

Command	Description
?	Get command menu Example: *?* *XCVR COMMANDS* *SPC:Get Time/Date T:Set Time/Date ^T:Resync towfish* *D:Check Output Power ^O:Power on/off ^B:Set bps rates* *G:Position Data ON g:Position Data OFF !:Xcvr/towfish versions* *COMMANDS* *SAMPLING- 1:4Hz 2:2Hz 3:1Hz 4:0.2Hz 0:Stop* *F:Single Reading I:Initialize Tuning L:Set Tuning* *y:autotuning off x:autotuning on <,>:adjust tuning* *u:show sensor tuning* *SPC:Get Time/Date T:Set Time/Date p:Zero Depth P:Calibrate Depth* *n:Noise Test m:IMU raw D:Batt/Depth/Alt/Hdg b:Enable/Disable Devices*
Space	Get Time and Date. Requests current magnetometer time, which is displayed with a resolution of 0.1 seconds in a 24-hour cycle. The oscillator used to keep time on the magnetometer has a frequency stability of 1 ppm over its entire temperature range, so a SeaQuest may gain or lose a maximum of 86.4ms in a day in the worst possible environment. SeaQuest's time is automatically set to the Real Time Clock of the transceiver each time it is connected. If a GPS connection to Transceiver is used, the Real Time Clock closely reflects the GPS clock. **Example:** *2021-12-16(350) 17:55:49.277*
d or D	Scan sensors. This command provides useful diagnostic information on the state of the platform at any given time. The first value is the battery voltage, followed by the current depth and altitude of the platform, then the strength of the signal currently coming from the altimeter, followed by the orientation (attitude) of the platform (pitch, roll, heading). If a GPS connection to Transceiver is used, satellite lock and time synchronization difference between magnetometer and GPS are also shown. **Example:** *D* *Output 45.3V, 138mA, 06.2W Lock(90ms)* *B43.0V D+0000.0m A000.93m S2880mV p+01.39 r-117.97 h258.11*

T	Input time manually. The magnetometer will respond with a prompt to enter eleven digits that represent a date and a time. There is no carriage return necessary. As soon as the eleventh digit is received, time will start from the entered value. The first three digits are Julian day, followed by two digits for year, and six digits for time in HHMMSS format. Note that this command can be executed while the system is cycling (taking readings). **Example:** *T* *Enter Time (yymmddhhmmss)* *221214173528* *Time set - 2021-12-14(348) 17:35:28.000* *Setting Towfish Time...* *Towfish time was set*
f or F	Take a single reading. The SeaQuest will immediately respond with an acknowledgement, and start the reading procedure, which will take 3 seconds If the tuning value is 0 when the reading is started, tuning initialization will automatically be performed. On conclusion, the SeaQuest will transmit the data obtained from the reading.
4	Start sampling at 0.2 Hz
3	Start sampling at 1 Hz
2	Start sampling at 2 Hz
1	Start sampling at 4 Hz
0 (zero)	Stop sampling. This command will terminate all cycling. The SeaQuest will complete a reading if one is in progress at the time of the command, and return to idle mode (awaiting further commands).
p	Set the depth sensor zero pressure. Use this command prior to survey while the towfish is out of the water. This will calibrate the zero level for the depth transducer. The response will report the actual zero level in mV.
P	Set depth sensor scale. This command will calibrate the slope parameter used to calculate the depth of the fish. Select options 1-3 to use a factory default value, or for higher accuracy press 4 to calibrate manually. The fish should be submerged under 1 to 9 meters of water when this command is executed. The unit will prompt for the depth of the fish. Press **ctrl-X** to abort. The response will report the new slope in mV/m.
y	Auto-tuning off. By default, an optimal tuning value is calculated at the end or every reading with 100 or more zero crossings. Fast changes in magnetic field may cause the unit to mistune. This command may be used to disable auto-tuning.
x	Auto-tuning on. Use this command to re-enable auto-tuning. Auto-tuning should be enabled for most situations, except when testing the magnetometer in a strongly-magnetic environment, such as inside a building or on the deck of a ship.
l or L	Enter tuning value manually. When this command is sent, the unit will prompt for the entry of a new two-digit tuning value in µT. The magnetometer will calculate the actual tuning step number that may be incremented or decremented by the following commands.
. or >	Increment tuning. This adjusts the magnetometer tuning in the smallest possible step. The number of that step is reported as a response to the command, and also the corresponding magnetic field value in µT. If auto-tuning is not selected, the default tuning value is zero, which will cause a tuning initialization when the first reading is attempted. If auto-tuning is disabled, the default power up tuning value will be whatever the setting was when the unit was powered off.
, or <	Decrement tuning.

R or r	Toggle RF Power. R: Enable r: Disable This command may be used to turn the RF polarization circuit on or off manually. If you are measuring the unit's power consumption, you will see the current draw increase in response to this command. The RF is turned on automatically when the magnetometer is taking readings.
!	Get platform serial number, firmware version and platform sensor separations. **Example:** *!* *Xcvr s/n: 6601* *Xcvr Firmware 2.00* *SQ s/n: 14101* *SQ Firmware: 1.70* *Sensor Separation H:1500mm V:750mm L:810mm*
G or g	Display GPS time and position data. G: Enable g: Disable Use this to verify the GPS connection to the Transceiver. GPS NMEA data is used to synchronize the towfish date and time to the GPS, to ensure best match between the magnetometer readings and the GPS positions. GPS positions from the Transceiver are not used by the data logging software. A separate GPS connection to the computer is required. When GPS is connected, the following data will be displayed: *@21.354/14:32:13.200 la+43.4557094 lo-079.2541113 sp000.04 tr195.20 dp01.2 sa10* When GPS is not connected, no data will be displayed, and the Transceiver will rely on its Real Time Clock to synchronize the towfish.

Table 6-1 - Normal operating commands

6.2 *Isolation Transceiver Commands*

The Isolation Transceiver (IT) inserts an intelligent layer between the host PC and the SeaQuest platform, allowing it to optimize the telemetry system parameters for a wide variety of tow cable specifications and lengths.

All normal SeaQuest commands are perfectly valid when using an IT. In addition, several commands are available to access IT functions. These commands are valid whether there is a SeaQuest connected to the tow system or not.

When the transceiver is powered up, it will attempt to verify if a SeaQuest is connected or not. This may take 3 to 4 seconds. If it detects a SeaQuest, it will immediately set the SeaQuest time to the transceiver time.

A rechargeable lithium battery is used within the transceiver as the power source for the internal clock. The transceiver will keep time for approximately three months if left ‘on the shelf’. If power is connected at any time, the on-board battery will automatically recharge. This battery never requires replacement under normal usage.

Command	Description
SPC	Gets time and date of the transceiver Real Time Clock. If a SeaQuest is connected it will also check the SeaQuest time and synchronize it to the transceiver time if there is a discrepancy.
T	Sets transceiver Real Time Clock time and date. As soon as the time is set, the transceiver will attempt to set the time of the SeaQuest, provided one is connected. The transceiver will remember the time after it is powered off.
Ctrl+T	Resynchronizes SeaQuest time with transceiver time.
d or D	Check Output Power. In addition to querying the SeaQuest, as described in Table 6-1 - Normal operating commands Table 6-1, this command also displays the voltage being supplied by the transceiver, and the current and power consumption of the SeaQuest.
Ctrl+O	Power On/Off. Toggles power to the SeaQuest. Disables power to the towfish, but maintains power to the Transceiver.
Ctrl+B	Change transceiver baud rates. Controls the baud rate between the SeaQuest and the transceiver, and between the PC and the transceiver, as well as the GPS port.
G or g	Display GPS time and position data. G: Enable g: Disable Use this to verify the GPS connection to the Transceiver. GPS NMEA data is used to synchronize the towfish date and time to the GPS, to ensure best match between the magnetometer readings and the GPS positions. GPS positions from the Transceiver are not used by the data logging software. A separate GPS connection to the computer is required. When GPS is connected, the following data will be displayed: `@21.354/14:32:13.200 la+43.4557094 lo-079.2541113 sp000.04 tr195.20 dp01.2 sa10` When GPS is not connected, no data will be displayed, and the Transceiver will rely on its Real Time Clock to synchronize the towfish.
!	Get platform serial number, firmware version and platform sensor separations.
*	Enters transceiver diagnostic mode. A security code is required.

Table 6-2 - Isolation Transceiver commands

7 SeaQuest Data Format

7.1 SeaQuest Raw Data Format

The SeaQuest data is in ASCII text format and appears as follows, always beginning with *:

```
*YY.JJJ/HH:MM:SS.S V[FFFFFF.FFF SSS TTTT G] P[FFFFFF.FFF SSS TTTT G] S[FFFFFF.FFF SSS TTTT G] R[FFFFFF.FFF SSS TTTT G] A[AAA.AAm aaaa] D+DDDD.Dm p+PP.P rRRR.R hHHH.HH*CS
```

Example:

```
*21.354/15:46:44.5 V[053577.250 141 0465  ] P[053585.399 209 0465  ] S[053579.264 207 0465  ] R[053586.093 221 0465 ] A[599.99m 0373] D-0002.4 p-08.04 r-006.65 h047.57*2A
```

Each letter shown in bold italics stands for a numerical digit of a particular record in the reading.

Letter	Description
YY	Year (time of reading).
JJJ	Julian day (time of reading). Also known as Day Of the Year.
HH	Hours (time of reading).
MM	Minutes (time of reading).
SS	Seconds (time of reading).
F	Magnetic field (nT).
S	Signal strength of reading. This is a raw number generated by the magnetometer that gives (in part) a good indication of the quality of the final total field measurement. A value above 200 is considered an acceptable signal, and anything above 300 is considered excellent. Values below 100 are considered poor, and may need to be excluded during post-processing.
T	Measurement time. Ideally, this should be the magnetometer's cycling time minus 35ms, with a maximum of 965ms. If you see a G message, indicating that measurement was prematurely terminated due to a high gradient condition, this value will tell you how severe the gradient is.
G	Gradient condition. In high magnetic gradients, the signal produced by the sensor decays more rapidly. This message occurs if the measurement time was prematurely terminated due to a signal decaying too rapidly. The strength of the gradient can be estimated by observing the measurement time. Note that sensitivity will decrease as the measurement time decreases. Readings accompanied by the Gradient condition flag are less reliable, and may need to be excluded in post-processing.
A	Platform Altitude (m). If an Altimeter is installed, but it cannot obtain a 'lock' on the seafloor (for example if it is too far away) this value will be 599.0m. If the altimeter is not functioning, this value will disappear from the data string entirely.
a	Signal strength of altitude reading.
D	Platform Depth (m). This is the depth relative to the zero-level, as set by the user at the start of survey.
PPP	Platform Pitch. Positive with the Nose downwards.
RRR	Platform Roll. Positive with the Port wing upwards.
HHH	Platform Heading in relation to the Magnetic North. Positive clock-clockwise.
****CS***	Check sum

table 7-1: Standard SeaQuest Data Format Description

The first character of each line is always * (ASCll code 42). This leading character is supplied for automated data collection systems that require periodic synchronization with the data stream. The leading * should not be confused with the * that precedes the check-sum at the end of the string.

The following letter designators appear throughout the string, identifying data types (table 7-2).

Letter	Meaning
V	Information from vertical sensor following
P	Information from port sensor following
S	Information from starboard sensor following
R	Information from rear sensor following
A	Altitude reading following
D	Depth reading following
p	Pitch reading following
r	Roll reading following
h	Heading reading following

table 7-2. Letter designators in the Raw Data Log

7.2 Calculating the Magnetic Gradients

The SeaQuest is designed to measure magnetic gradients (the spatial difference in the magnetic field over a linear distance). Note that the magnetic gradients are not reported as part of the data string; these must be computed by the data logging software, or during post-processing, using the appropriate sensor separation distances.

The SeaQuest outputs the raw magnetic field at each sensor pod location. To calculate magnetic gradient, use the formula:

$$\frac{dB}{dx} = \frac{B_1 - B_2}{x} \quad \text{[nT/m]}$$

In this formula, $\frac{dB}{dx}$ is the magnetic gradient in the x direction. B_1 and B_2 are the total field measurements from two sensors, and x is the distance between the sensors in meters. In S.I. units, magnetic gradient is expressed as nT/m.

Marine Magnetics BOB software computes the magnetic gradients as follows:

$$\frac{dB}{dx} = \frac{B_{center} - B_{rear}}{l} \quad \text{(longitudinal gradient)}$$

$$\frac{dB}{dy} = \frac{B_{starb} - B_{port}}{h} \quad \text{(horizontal gradient)}$$

$$\frac{dB}{dz} = \frac{B_{vert} - B_{center}}{v} \quad \text{(vertical gradient)}$$

Where:

$$B_{center} = \frac{B_{stb} - B_{port}}{2} \quad \text{(center field)}$$

Total Magnetic Gradient (Analytic Signal):

$$|AS| = \sqrt{\left(\left(\frac{dB}{dx}\right)^2 + \left(\frac{dB}{dy}\right)^2 + \left(\frac{dB}{dz}\right)^2\right)}$$

Refer to Table 1-1 - SeaQuest2 Sensor separations.

8 *Interfacing to a Side Scan Sonar*

A SeaQuest can be towed simultaneously with a multitude of different side scan sonar units. A variety of factors, including connection details, deployment method, and operating parameters will vary depending on the type of side scan you are working with. The SeaQuest must be configured differently depending on the side scan system being used. The following table shows the relevant electrical specifications for interfacing with a side scan sonar unit. Ensure that your side scan unit can output the required data rate, voltage level and power listed below. It is also essential that the side scan sonar unit provides bidirectional communication with the SeaQuest system.

Parameter	Min	Typ.	Max	Units
Input Voltage	9	24	27	VDC
Input Power	6	12	14	W
Output Voltage	48	48	48	VDC
Output Current - fused	-	-	1.0	A
Output Power	6	12	14	W
RS232 Baud Rate	38400	115200	115200	bps

Table 8-1 - Side Scan Integration electrical specifications

8.1 *Analog Systems*

In general, interface to an analog side scan sonar system requires the use of a tow cable that is capable of carrying the sonar signal and SeaQuest telemetry on separate conductors. Electrically, this is identical to running both systems stand-alone, but packaging their tow cables under a single jacket for most of the deployment length.

Since this type of interface depends on the type of tow cable used more than the actual type of side scan unit deployed, these types of integrations will almost always be custom-made for a specific configuration or application. Operation of the SeaQuest towfish is exactly as it would be in a stand-alone configuration.

8.2 *Digital Systems*

Interface to a digital side scan sonar system involves sending the digital data output from the SeaQuest to a data input port on the side scan unit. The side scan unit's telemetry is then used to relay the magnetometer data to the surface, where it is then decoded from the side scan data stream. Also, the SeaQuest towfish draws power directly from the side scan unit.

Interfacing a SeaQuest to a digital side scan sonar system is inherently more complex than to an analog system, but it has the benefit of not requiring extra conductors in the tow cable. Furthermore, fewer components are needed topside, since only a single telemetry decoder is required. This allows the SeaQuest to simply 'plug in' to an existing working setup.

Clearly, the two instruments work very closely together in such a configuration. Specific design features have been added to SeaQuest magnetometers, and to several side scan products to allow seamless, trouble-free operation together. Table 8-1 shows the requirements for interfacing a side scan sonar unit with the SeaQuest system. In all cases, a magnetometer interface kit is required from the side scan sonar manufacturer.

ALWAYS ENSURE THAT THE SIDE SCAN UNIT IS OFF BEFORE CONNECTING OR DISCONNECTING THE INTEGRATION!!!

8.3 Communication

The SeaQuest will only work with side scan systems that provide bidirectional communication with the SeaQuest. With these systems, the SeaQuest is controlled the same as in stand-alone mode. Only the baud rate has to be programmed correctly before deployment.

8.4 Baud Rate

The SeaQuest baud rate can be configured using the **ctrl-B** command. Ensure that the SeaQuest baud rate matches that of the side scan unit being used. Note that if the baud rate is not set correctly prior to connecting the towfish to the side scan unit, no communication will be possible.

8.5 Electrical Power

The SeaQuest Side Scan Integration electronics will accept input voltages ranging from +9 to +27VDC and generate +48VDC output to power the magnetometer. If the output current to the magnetometer exceeds 1.0A, an internal fuse will trip and stay tripped until the output load returns to a reasonable level. It will then automatically reset itself. A short in the tow cable or at the brass tow connector will not cause damage to either the interface electronics or the side scan system itself.

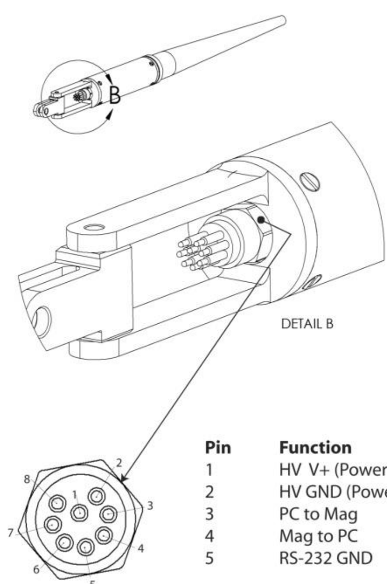
The SeaQuest Side Scan Integration can also be powered through the test cable provided. The test cable includes an AC power supply with an output voltage of +48VDC. **Note: The SeaSPY Side Scan Integration test cable cannot be used to power the SeaQuest Side Scan Integration.**

8.6 Mechanical Tow Point and Electrical connector Pin-out

The Side Scan Integration consists of a stainless steel interface housing that functions as a tow point, and contains power conditioning and interface electronics. The interface housing is permanently connected to a 10m tow cable that is terminated with a standard SeaQuest brass tow connector on the other end.

The interface tow point connects to an extension bar that is fastened to the side scan towfish at its center of gravity or at the rear of the platform for heavier units. The side scan tow cable connects to the top of the bar, and the SeaQuest interface clips directly to the bar with a clevis pin, through a universal link that allows full rotation in two dimensions. There are two different types of universal links available (a tab or a slot), depending on which side scan system is being used.

The Side Scan Integration uses an 8-pin Subconn micro-circular connector (p/n MCBH8M) which mates with a female inline connector (p/n MCIL8F)..



Pin	Function
1	HV V+ (Power V+)
2	HV GND (Power GND)
3	PC to Mag
4	Mag to PC
5	RS-232 GND

9 Maintenance

A SeaQuest system is designed to withstand years of use in harsh marine environmental conditions. If some simple procedures are observed when deploying and storing the instrumentation, your SeaQuest system will continue to deliver high quality performance with no need for service at the Marine Magnetics facility.

- When connecting the main tow connector, ensure that the alignment slot is properly inserted into the groove, and that the male connector is fully inserted. Tighten the holding nut firmly.
- Always allow the towfish to come to the ambient water temperature before beginning the survey. Allow the magnetometer to be immersed in water for 5-10 min prior to calibrating the zero-depth on the depth sensor. The temperature difference between deep water and deck of the vessel can be significant!
- Use a tow speed and cable length combination that keeps the towfish submerged at least 1m below the surface, and as far below waves and swell as possible if the water is rough. Other than this, there is no restriction on tow speed.
- Do not, under any circumstances, exceed the maximum rated operating depth of the towfish. In some cases, permanent damage may occur to certain components (such as the pressure sensor) if the towfish's rated depth is exceeded by even a small amount.
- Rinse the towfish with fresh water after removal from salt water. Surface corrosion of the brass fittings and screws will only significantly take place after exposure to atmospheric oxygen in the presence of salt water. Rinsing with fresh water will keep the brass fittings clean and shiny. If possible, also rinse inside the wings through the available drainage holes.
- Blow out the pressure sensor hole with **compressed air** after removal of the towfish from salt or fresh water. Stagnant water in the pressure sensor hole can cause pitting corrosion of the pressure sensor after long-term use.
- Do not store the towfish in direct sunlight, and keep it away from very hot environments. The operating and storage temperature range for a towfish is -40˚C to +60˚C, but an unsheltered towfish in a sunlit area can easily exceed +60˚C. Keeping the towfish stored in moderate temperatures will prolong the lifetime of the seals and the internal electronics, as well as protect the exterior from UV light.
- During transit to and from the work site, store the towfish in its transit case, or if stored on deck, the towfish should be laid flat on the decking. Never stand up the tow fish vertically unless you are absolutely sure it cannot fall or be knocked over.
- The zinc sacrificial anodes on the horizontal gradiometer frame are designed to prevent the corrosion of the anodized aluminum by corroding first. In corrosive salt water environments these zinc anodes will need to be replaced from time to time.
- All O-rings used in the SeaQuest platform are made from 70-durometer nitrile-rubber. All sizes are ASTM.
- The only 'consumable' O-rings in the platform, i.e. the only O-rings undergoing repeated motion, are those used on the tail flange and on the wing sensor cable coaxial connectors. Other O-rings will not need replacement unless the individual pods are disassembled and the O-ring receives mechanical damage.
- When replacing O-rings, ensure that the new rings are well greased, and free from dust and dirt particles. Also ensure that a coating of grease exists on the mating surface, and that it is free from scratches or gouges.

10 Troubleshooting

The transceiver provides detailed diagnostic information about the status of the system. It is important to ensure that the transceiver is working properly before trying to diagnose and fix other issues. **Disconnect all cables from the transceiver before proceeding.**

10.1 Transceiver Test Procedure

1) **Power the transceiver**

Connect the *AC Power Supply* or *Battery Clip* cable to the power source and then to the transceiver.

2) **Check the status of the *Power* LED**

If the ***Power* LED is orange** then the transceiver has powered up properly. Proceed to step 3.

If the ***Power* LED is off** then the transceiver is not receiving power. Verify the connection from the power supply to the transceiver and from the power supply to the AC power lines. If you are using a battery, check the battery voltage. The transceiver requires an input voltage in the range of +9 to +28VDC. Use a voltmeter to verify the voltage across pins 1 and 2 on the 3-pin connector that plugs into the transceiver.

If the ***Power* LED is red** then the transceiver is experiencing an output overload that is causing the internal poly-fuse to trip. This usually indicates a short on the output path of the transceiver. If this occurs with nothing connected to the output (2-pin connector) of the transceiver then verify that nothing is shorting the pins on the 2-pin connector, and then contact Marine Magnetics directly for assistance.

If the ***Power* LED is green** then the towfish is connected. Remove the deck leader cable from the transceiver and start the checklist again. If the deck leader cable is not connected then the transceiver is not working properly. Contact Marine Magnetics directly for assistance.

3) **Check the status of the *Comm* LED**

The *Comm* LED should be off if no towfish is connected. If the *Comm* LED flashes blue without a towfish connected, the transceiver may be malfunctioning. Contact Marine Magnetics directly for assistance.

4) **Connect the transceiver to your PC using the RS232 or USB cable**

Identify which COM port the transceiver is connected to. If you are using the USB cable then a virtual COM port will be created if BOB is installed. You can check the COM port using Windows Device Manager.

5) **Open BOB software and access the terminal window**

Open BOB and navigate to the terminal window. For more information about using BOB refer to the BOB Operation Manual.

6) **Issue the Scan Sensors command (d or D)**

The response from this command should be a single line of data in the terminal window indicating the output levels from the transceiver (e.g. *Output 46.0V, 000mA, 00.0W*). Verify that the power consumption is zero and that the output voltage is around 48V.

7) **Connect the SeaQuest to the transceiver**

Ensure that the magnetometer, tow cable and deck leader are all connected when the deck leader cable is connected to the transceiver. If everything is connected properly then the *Power* LED should turn solid green and the *Comm* LED will flash blue temporarily while the SeaQuest transmits its start-up header string. If the *Power* LED turns red then there is a possible short in one of the cables, which can be caused by a damaged cable or connector. Refer to Table 10-1 - Troubleshooting specific issues (page 40).

10.2 SeaQuest Test Procedure

If the SeaQuest is communicating properly, then the following procedure will verify that the magnetometer is operating correctly and is ready for a survey.

1) Check the clock in the magnetometer and transceiver

Issue the **SPC** command twice to check the clock. Verify that the time has advanced from one line to the next.

2) Scan the sensors

Issue the **d** or **D** command to check the state of the towfish. If you are using an Isolation Transceiver then it will respond to the command with the first line of data before the SeaQuest responds with the second line. The following is a sample response to the **d** command.

21.354/14:49:15.0

Output 45.4V, 146mA, 06.6W Lock(10ms)

B42.8V D+0064.0m A000.00m S0202mV p-07.94 r-006.47 h048.43

The output voltage should be close to 44V (30V with a side scan integration) and the current will depend on the state of the system. Note that the GPS time lock status (Lock(10ms)) will only be present if the transceiver has a GPS connected to it.

3) Activate the RF polarization circuit

Issue the **R** command to activate the polarization circuit and then send the **d** command again. You should notice the current draw increase by about 150mA with the RF circuit activated. Deactivate the polarization circuit with the **r** command.

Output 45.5V, 138mA, 06.2W Lock(10ms)

RF ON

Output 44.0V, 283mA, 12.5W Lock(10ms)

4) Zero the depth sensor

If the depth sensor is reading greater than +000.5m while out of the water then you should zero the pressure sensor using the **p** command.

The best way to set the correct zero depth level is to submerge the SeaQuest for 5-10 minutes to allow the depth sensor to adjust to the water temperature , then raise the SeaQuest out of the water and send the p command to set zero level.

5) Start Sampling

In order to test the SeaQuest magnetometer sensors, the unit needs to be far from any magnetic material. If you are testing on land then ensure that the SeaQuest is far from any buildings or other ferrous material. If you are on a vessel then deploy the platform from the stern at a distance of at least 3 times the length of the vessel.

*Start cycling at 1Hz by issuing the **3** command and take 5 to 10 sample readings. Each reading should be similar to the following.*

**21.354/14:42:27.0 V[053579.486 265 0465] P[053587.354 136 0465] S[053581.720 231 0465] R[053588.417 237 0465] A[599.99m 0358] D+0064.5 p-07.78 r-007.38 h047.52*26*

Systems equipped with a GPS Integration will display a separate data string with location information.

**21.354/14:42:27.0 V[053579.486 265 0465] P[053587.354 136 0465] S[053581.720 231 0465] R[053588.417 237 0465] A[599.99m 0358] D+0064.5 p-07.78 r-007.38 h047.52*26*

@21.354/14:42:27.0 la+43.8552094 lo-079.3511113 sp000.04 tr195.20 dp01.2 sa10

Notes:

- Some of the fields may not be visible depending on the number of sensors used.
- The value of the magnetic field may differ significantly when tested at your location.
- The value for the magnetic field signal strength should be above 250 for good quality readings.
- The value for the ms reading should be close to 0965.

If the SeaQuest passes all of these tests then it is functioning properly and is ready for operation.

10.3 Side Scan Integration Test Procedure

The following procedure can be used to test a SeaQuest with a Side Scan Integration unit. Before connecting the magnetometer to the side scan unit, you can use the test cable to verify that everything is operating correctly.

1) Connect the test cable to the Side Scan Integration

Attach the female DB9 connector to the serial port on your computer. Connect the 8-pin female Subconn connector to the Side Scan Integration unit and then plug the 3-prong power connector into an AC power source.

2) Open BOB software and access the terminal window

Identify which COM port the integration is connected to. This can be done using Windows Device Manager. Open BOB and navigate to the terminal window. For more information about using BOB refer to the BOB Operation Manual.

3) Connect the Side Scan Integration to the SeaQuest

Attach the tow connector end of the Side Scan Integration cable to the SeaQuest. The blue LED on the Side Scan Integration should flash momentarily as the SeaQuest sends its start-up header string to the PC. You should see this data appear in the terminal window in BOB. The LED will flash anytime data is received from the magnetometer.

4) Follow the SeaQuest test procedure outlined in Section 10.2 (page 36).

5) Connect to the side scan unit (powered off)

ALWAYS ENSURE THAT THE SIDE SCAN UNIT IS OFF BEFORE CONNECTING THE INTEGRATION! Disconnect the Side Scan Integration test cable and connect the integration directly to the side scan unit using the 8-pin Subconn connector.

6) **Follow the side scan manufacturer's instructions for operating with a magnetometer.**

Table 8-1 shows the electrical requirements for operation with a side scan sonar unit.

7) **Repeat the SeaQuest test procedure outlined in Section 10.2 (page 36) to ensure that the system is still working properly.**

ALWAYS ENSURE THAT THE SIDE SCAN UNIT IS OFF BEFORE CONNECTING OR DISCONNECTING THE INTEGRATION!!!

10.4 Troubleshooting

The following table addresses specific issues that may occur. For more details or other issues please contact Marine Magnetics technical support.

Symptom	Possible causes	Solution
Transceiver *Power* LED is off	• Insufficient power is being supplied to the transceiver • Power supply cable or connector damaged	• Verify the connection from the power supply to the transceiver and from the power supply to the AC power lines • If you are using a battery, check the battery voltage • The transceiver requires an input voltage in the range of +9 to +28VDC. Use a voltmeter to verify the voltage across pins 1 and 2 on the 3-pin connector that plugs into the transceiver
Transceiver *Power* LED is red ***OR*** ***Output Overload! message*** ***OR*** **Towfish is drawing more current than the maximum specification**	• There is a short in the cable or in the SeaQuest • Water is present in the circuit • Slip-ring is wired incorrectly	• Starting from the towfish end of the system, remove one component or cable at a time until the LED turns orange • If the LED remains red with the deck leader disconnected from the transceiver then try cycling the power to the transceiver • If the cable is determined to be the issue, then examine it for cuts or leaks and inspect the connectors for damage or shorts • If the SeaQuest is determined to be the issue, then inspect the connector. Also, ensure that the O-rings are intact on the sensor cables • Using an ohmmeter, verify that none of the cables or connectors are shorted
Transceiver *Power* LED is orange ***OR*** **Towfish is drawing less current than the minimum specification**	• No towfish is connected • Towfish power has been turned off by the transceiver	• Connect the towfish • Make sure enough voltage is being supplied to the towfish • Turn the towfish power back ON by sending the Ctrl+O command to the transceiver
No response from the towfish	• Error in the equipment setup or communication settings	• Make sure all cables are connected and the *Power* LED on the transceiver is green • Make sure the baud rate and the communication protocol of the terminal software are set correctly
Communication issues	• Insufficient voltage • Damaged tow cable / jacket • Damaged or leaking tow connector on the tow cable • Poor wiring or grounding through slip-ring	• Check the voltage going to the SeaQuest • Inspect all cables and connectors for damage or bent contacts • Inspect the slip-ring connections
Poor magnetic field readings	• External noise affecting the sensor(s) • Power supply amplifiers are adding noise to the system	• Move the SeaQuest to a different location, away from metal or magnetic sources and try sampling again • Ensure that the SeaQuest is far enough behind the vessel (at least 3 times the length of the vessel) • Ensure SeaQuest is submerged and not affected by surface waves • Avoid interferences such as radio waves, train tracks, on-board generators, metal hardware on the SeaQuest of tow cable within 5m of the SeaQuest • Use a 24V DC battery instead of AC power to power the system • Ensure the power supply is properly grounded to the vessel/sea ground

Towfish Leak	• Core Body housing damaged from impact • Damaged O-ring • Maximum depth rating exceeded for SeaQuest • Core plug is not installed in the rear of the core body when longitudinal sensor is not used	• Shutdown towfish • Retrieve towfish immediately • Unscrew nose bulkhead • Check for water • If water is present then examine housing and O-rings for damage • Ensure that the core plug is installed if not using a longitudinal sensor
Noisy or erroneous altimeter readings	• SeaQuest is affected by propeller turbulence from vessel • SeaQuest platform is pitching/rolling too much, or affected by surface waves	• Tow the SeaQuest farther behind the vessel. Submerging the platform below the prop-wash will also help • Tow the SeaQuest below the waves to increase platform stability. Rough sea conditions may not be suitable for surveying
Depth reading drifts after deployment	• The pressure sensor was not zeroed at ambient water temperature	• Submerge the platform for 10 min to allow depth sensor to reach ambient water temperature, then retrieve unit to the surface or just above surface, and zero depth sensor using the **p** command
Platform heading is incorrect	• Magnetic material is affecting the magnetic field around the integrated IMU	• Ensure the unit is positioned far away from any highly magnetic materials or buildings

Table 10-1 - Troubleshooting specific issues

10.5 *Electrical Specifications*

The following table shows the expected measurements under working conditions. If you are experiencing abnormal results then consult table Table 10-1 - Troubleshooting specific issues.

Location	Parameter	Min	Typ.	Max	Units
Transceiver	Input Voltage	9	24	28	V
@ 24V	Input Current (no towfish)	60	66	75	mA
	Output Voltage	40	47	48	V
	Output Current	-	-	1.0	A
Side Scan Integration	Input Voltage	32	48	225	V
	Output Voltage	25	30	32	V
	Output Current	-	-	1.0	A
SeaQuest	Input Voltage[1]	30	43	50	V
Cycling	Input Power	-	16	20	W
Standby @ 48V	Input Current[2]	140	160	180	mA
Standby @ 48V	Input Current[2] (with GPS Integration)	180	210	240	mA
Cycling @ 48V	Input Current[2]	290	310	330	mA
Cycling @ 48V	Input Current[2] (with GPS Integration)	330	360	390	mA
Tow cable	Resistance (along conductors)	-	15	-	mΩ/m
	Resistance (between conductors)	10	∞	-	MΩ

Table 10-2 - Electrical specifications

Notes:

1) The voltage will drop over extremely long cables and may cause the current consumption values to increase. This is normal. For optimum results, we suggest performing these tests over as short a cable as possible.

2) When the system is in standby, the current consumption will be quite constant. When a command is sent to the towfish, a short jump in the current consumption can be observed, which is due to the towfish communication circuitry powering up momentarily.

11 How to Reach Us

If you encounter a problem using your SeaQuest system, you should contact the distributor that you received the product from. You can also contact Marine Magnetics directly at the address mentioned below. If you have access to the Internet, our World Wide Web page offers support in the form of documents and file utilities, as well as information on product updates.

Marine Magnetics

135 SPY Court
Markham, ON L3R 5H6
Tel: 1 905 479-9727 fax: 1 905 479-9484
Email: support@marinemagnetics.com
URL: www.marinemagnetics.com

11.1 Warranty

All of the equipment manufactured by Marine Magnetics, with the exception of consumable items, is warranted against defects in materials and workmanship for a period of twenty-four months from the date of shipment. This warranty is not transferable.

During the warranty period, if any defects become evident under normal use, the buyer must notify Marine Magnetics of the defect and describe the symptoms in writing. Within thirty days of receiving said notification, Marine Magnetics will take action to remedy the defect or problem by choosing one or more of the following courses of action:

1. Replace the defective item(s)
2. Request the buyer to return the defective item(s) to Marine Magnetics for repair.

During the warranty period, replacement or repairs to items as described in 1 and 2 will be made free of charge. However, Marine Magnetics' liability in such cases will not extend to transportation charges for any item to or from the buyer, or to any lost time or to other costs that the buyer may incur.

If the buyer requests a technician on-site to complete the repair(s), the buyer will pay for all of the lodging, food and local transportation costs while the technician is affecting the repair(s).

During the warranty period, the *SeaQuest* should not be opened or repaired in the field, unless instructed to do so by Marine Magnetics technical support staff. **Opening the *SeaQuest* without Marine Magnetics technical support approval will render the warranty null and void.**

11.2 Indemnity

The Customer agrees to indemnify and save Marine Magnetics harmless from and against all loss, damage and expense whatsoever resulting from any personal injury or damages to property directly or indirectly caused by the Equipment or any part thereof during the term applicable to such Equipment, including the operation and handling of the Equipment.

11.3 Disclaimer

Marine Magnetics makes no representation or warranties and there are no conditions with respect to the merchantability, the suitability or durability of the Equipment or any part thereof for the purposes or uses of the Customer, unless the Customer notifies Marine Magnetics in writing of any defects in the Equipment or part thereof on delivery of such Equipment. All such Equipment or part thereof shall be deemed conclusively to have been delivered to the Customer in good and efficient working order and repair, and the Customer shall be deemed conclusively to have accepted delivery thereof on the date of delivery.