Explorer

Operation Manual

Revision 2.3

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1 Introduction

Explorer is a high sensitivity, total field magnetometer packaged in a rugged marine housing. Explorer's light weight, compact size, and ultra low power consumption make it the ideal tool for shallow water surveys, especially when deployed from a small craft. A standard Explorer system consists of the following components:

- A towfish unit that contains an Overhauser magnetometer sensor and driving electronics
- A high strength marine tow cable, containing four shielded conductors
- A Power Isolator Box (PIB) for galvanically isolating the towfish from the electrical power source and logging PC
- An RS232 interface cable that connects to a standard PC RS232 port
- A universal input (100 to 240VAC 50/60Hz) AC power supply that allows the system to be powered from line power anywhere in the world
- BOB data acquisition, visualization, and control software for Windows

Measurement of magnetic field is done completely inside the towed fish. The tow cable supplies power to the towfish, and provides a bidirectional digital communication link. All control of the fish is through RS232, using a PC or any RS232-capable computer.

The towfish requires DC power, with a range of +8 to +40VDC. In most cases, power will be supplied to the Explorer from the PIB, which produces a clean, constant +24VDC to power the towfish. The input range for the PIB is +9 to +28VDC.

The AC power supply (included with all complete Explorer tow systems) will produce a clean, constant +24VDC from 100 to 240VAC at 50/60Hz. The maximum power consumed by the fish is about 2W when acquiring data, and is typically around 0.5W when in standby. The PIB consumes an additional 1W.

1.1 Understanding the System Components

Marine Magnetics supplies a separate document called our *SeaSPY Technical Application Guide* that describes in depth how the magnetic sensor in the Explorer magnetometer works, and how it can be used for different applications. Marine Magnetics provides this document to anyone free of charge, so please contact us if you do not already have a copy.

1.1.1 Overhauser Total Field Sensor

This is the main sensor of the system. It operates on the proton spin resonance principle, but it is drastically different from a conventional proton magnetometer sensor. The proton-rich liquid within the sensor has been specifically engineered to allow a principle known as the Overhauser effect to occur within it. This effect allows the Explorer magnetometer to measure with one to two orders of magnitude more sensitivity but with a tiny fraction of the power of a standard proton sensor, while keeping the excellent absolute accuracy and operational characteristics that have made conventional proton sensors so popular.

All Explorers are supplied with an omnidirectional sensor that is completely isotropic with respect to magnetic field direction. The only restriction that must be observed is that **the fish must not be oriented vertically with the nose facing up**. 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 due to diurnal effects, which include influence from the Sun 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.

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 sensor to produce good results on the deck of a ship, or inside a building,** any more than you would expect a high-powered telescope to see distant stars in the middle of the day.

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

1.1.2 Temperature Sensor

A silicon temperature sensor is located inside the towfish. Although there is a considerable delay between a temperature change outside the towfish and a change inside the towfish when it is traveling through water, this sensor provides a good indication of the temperature of the towfish electronics. In text mode, temperature is available in units of degrees C, with a precision of 0.1 degrees. The range of the sensor is −50°C to +150°C. Note that the temperature inside the towfish will slowly rise to about 15 to 20°C above ambient when the unit is acquiring data.

1.1.3 Leak Detector

Explorers are equipped with leak sensors that sound a warning when water is present inside the towfish housing. Every reading, in text mode, displays an 'Lx' parameter, where x is a number between 0 and 9. A value of 9 indicates that water is present.

Even a small drop of water will activate the leak sensor. **If your leak warning sounds, chances are that a leak has developed in the towfish housing, and it should be retrieved immediately.** If the towfish is allowed to fill with water to high pressure, damage may result to the electronics or Overhauser sensor.

1.1.4 Pressure Sensor

The standard Explorer pressure sensor is a Wheatstone bridge on a silicon diaphragm. The maximum pressure that this sensor can stand before potentially suffering damage is 500psi (345m of water). Exceeding this 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 twice that pressure (about 689m of water).

Note that the standard Explorer housing as a whole is rated to a depth of 300m, which should never be exceeded or damage to the housing may result.

Explorers can interface seamlessly to a variety of other pressure sensors, suited for shallow or deep water surveying. In general, a larger pressure sensor range will result in lower precision in the pressure reading. The table below lists the different pressure sensor types, their required housing ratings, and the corresponding maximum precision.

Range (psi)	Range (m)	Precision	Housing
100	69	0.1 m	300m standard
500	345	0.1 m	300m standard
2500	1725	0.5 m	800m standard
5000	3450	1 m	2000m deep-tow
10000	6895	2 m	6000m deep-tow

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. In moderate climates, this can be done on the deck of your ship; however, for optimal results the towfish should be submerged to allow the temperature of the pressure sensor to reach the ambient water temperature. The **p** command will zero the pressure sensor.

The **P** command will display the current pressure sensor 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.

The pressure sensor may be calibrated by entering the factory full-scale calibration value; by entering a nominal value that is valid for a generic sensor of a given pressure range; or by submerging the towfish to a known depth and entering that depth.

1.1.5 Electronics

The Explorer electronics is the core of the Explorer system, located within the towfish (Figure 11-2). The electronics control all of the sensors in the towfish, monitor their performance, and report their data to the host acquisition device digitally over the tow connection.

The explorer contains two electronics boards: a power board, and a signal processing board. The electronics module requires approximately 0.5W of power in standby (waiting for commands), and approximately 2W at full power while sampling the magnetic field.

1.1.6 Towfish

The Explorer towfish is a pressurized vessel that carries all of the system sensors and the Explorer electronics. It consists of a filament-wound fiberglass cylinder

coated with polyurethane for abrasion and shock resistance. The nose contains a brass tow connector that is designed to bear the entire load of the tow system, in addition to providing a four-conductor electrical connection.

A standard Explorer towfish is rated to a water depth of 300m (985ft). A depth rating option to 800m (2624ft) is also available. For a list of O-ring sizes in the housing seals, refer to section 10.2.

1.1.7 Power Isolator Box

The Explorer Power Isolator Box (PIB) consists of power-conditioning electronics to supply clean power to the Explorer, as well as optocouplers on all communication lines to provide isolation from the PC. 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 +9 to +28VDC allows for operation with both +12VDC and +24VDC vehicle batteries. Internal regulators produce a constant +24VDC to power the towfish. This hardware is sealed in a rugged, orange, aluminum housing that is splash proof. The PIB also supports USB for easy use with computers that do not have a standard serial port. For more information on how to connect the PIB, see section 3.

A PIB is able to communicate with an Explorer towfish across up to 200m (656ft) of the standard Explorer tow cable.

1.1.8 Tow Cable

The standard Explorer tow cable (blue in colour) contains four conductors plus a shield and a high strength, lightweight, braided Kevlar strength member. The tow cable can withstand loads of up to 1000lbs without any damage, and loads of up to 5500lbs without breaking. The cable has a 1cm outer diameter, and a weight of 122g/m in air and 34g/m in water. 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.

Two 18-gauge conductors in the tow cable carry the towfish DC power (red and black in colour). The red conductor carries the positive voltage and the black conductor carries the negative voltage and common ground. The towfish RS232 signal is carried on two 22-gauge conductors (white and green). The outer shield is only used to shield the inner four wires from external noise, not carry electric current. It is connected to the cable's negative (black) conductor at the source (topside) end of the cable only.

1.1.9 RS232 Cable

The RS232 cable connects the PIB to your PC. 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 PIB.

1.1.10 USB Cable – Optional

The USB cable is an optional replacement for the RS232 cable. This cable is useful for laptops or computers that do not have a standard serial port. The USB driver supplied with BOB must be installed for USB functionality.

1.1.11 AC Power Supply

The standard Explorer AC power supply can accept any AC power from 100 to 240VAC, at 50/60Hz, and is therefore capable of operating worldwide. It produces a constant +24VDC to power the PIB and Explorer system.

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**. If not, you may experience communication problems, or even a degradation of magnetometer performance.

1.1.12 Battery Clip Cable – Optional

If AC power is unavailable, or if battery power is more convenient, the battery clip cable may be connected in place of the AC power supply. This cable has two large alligator clips for easy connection to a standard +12VDC or +24VDC vehicle battery.

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 will provide a range of +18 to +28VDC going to the Explorer system over the full charge cycle of the battery set.

The Explorer system has 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 more than +28VDC to the PIB and no more than +40VDC to the Explorer towfish.**

1.1.13 BOB Software

BOB is a Windows application that interfaces with your magnetometer, to allow full control over the towfish, and to display and record data. For detailed information on using this program refer to the *BOB Operation Manual*.

2 Communication

By default, all communication with the fish is via bidirectional RS232 using 9600 baud, eight data bits, no parity and one stop bit. Communication is full duplex.

Communication with the Explorer is accomplished by simple ASCII text commands. In this mode, only a simple ASCII terminal is required, which can be a PC running a terminal program such as Windows HyperTerminal, or the more advanced BOB software provided with your magnetometer system. For a list of available text commands, please refer to chapter 5.

When a command is sent from the PC keyboard it is relayed directly to the towfish. Therefore, when no towfish is connected, you will see no response when you send a command. As soon as you connect the towfish, you will see a power-up header that displays the current status of the towfish.

2.1 Power Isolator Box

The purpose of the Explorer Power Isolator Box (PIB) is to galvanically isolate the towfish from the electrical power source, logging computer, GPS system, as well as the hull of the surveying boat. This will improve immunity of the Explorer to the effects of noise originating at these sources, and eliminate the accelerated corrosion of metal components of the towfish caused by stray DC leakage currents. The PIB will also allow the magnetometer system to be connected to the logging computer via the USB interface.

2.1.1 Output Voltage

Standard PIB units are built to output +24VDC to the Explorer 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 PIB units use a 1.0A resettable input fuse. If your input voltage is too low, the PIB will have to draw more current to supply the same power to the Explorer tow system.

You can monitor the voltage at the towfish at any time by issuing the **d** command.

2.1.2 Status LEDs

The PIB has two status LEDs: one for power and one for communication. The *Power* LED is red if the PIB is powered but there is no towfish detected, and it is green if the towfish is detected. The *Comm* LED flashes green whenever data is being transmitted between the towfish and the PIB.

3 Connecting the Equipment

The Explorer magnetometer system is designed for quick and easy deployment and can be setup without the use of any tools. The following diagram shows how to properly connect the system. If you are using a side scan sonar with your magnetometer then refer to chapter 7 for further instructions.

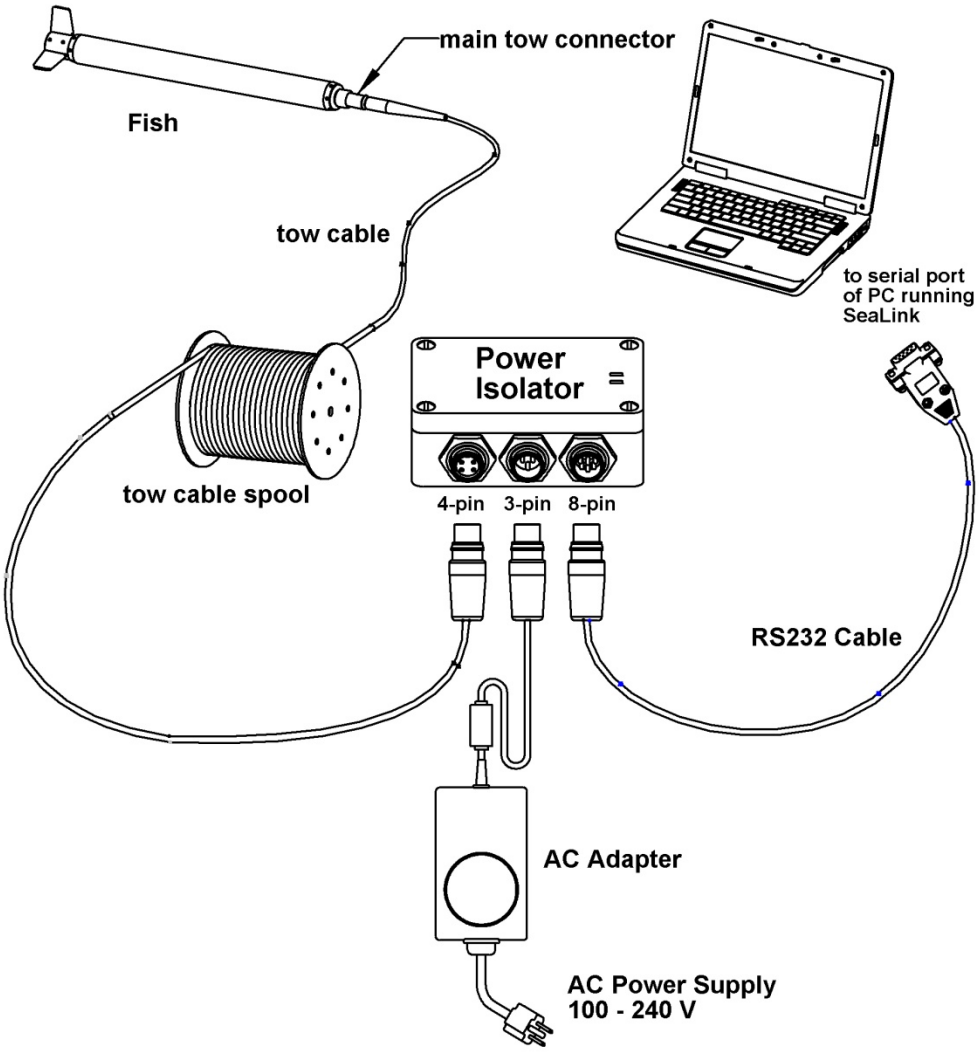


figure 3-1: Explorer connection diagram

NOTE: Before deploying the towfish, ensure that the main tow cable is firmly secured to the towing vessel.

3.1 Power Isolator Box

Connect the Power Isolator Box (PIB; the small orange box) to a PC or other type of host computer using the gray RS232 cable provided with the system. Plug the circular 8-pin female connector into the PIB 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 an optional Marine Magnetics 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 PIB and then plug the power cable into 100 to 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 PIB. Plug the circular 4-pin male connector end of the main tow cable into the PIB.

3.2 Main Tow Connector

The main tow connector provides the electrical connections to the towfish, and also bears the load of the towfish 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.

The male connector has a locking slot that fits into a groove in the female 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.

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 Explorer connection system. Keeping the connector in operational order requires very little effort. See section 10.1 for maintenance tips.

4 Getting Started

When the Power Isolator Box (PIB) is first powered up, the *Power* LED will glow red. If an Explorer is detected, then the LED will turn green and the Explorer's identification header will be displayed in the terminal window. You will notice the *Comm* LED will flicker green as data is transmitted between the Explorer and the PIB.

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 the towfish. The Explorer responds with the status of three important sensors, as well as the voltage at the towfish end of the tow cable. The first column shows the amount of signal currently being produced by the Overhauser sensor. This is a raw number between 0 and 255, and should nominally be less than 10 when the magnetometer is idle. The second column is battery voltage. The voltage should be at least +8VDC. If it is lower, communication may be erratic, and the magnetometer may not operate properly. The voltage drop between the PIB and the fish will depend on the length of your tow cable. The third and fourth columns display the temperature of the electronics, and the depth of the fish in meters, respectively.

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 fish has already cooled or warmed to the ambient air temperature, since the output of the depth sensor will vary slightly with temperature. For optimal results, submerge the towfish to allow the temperature of the pressure sensor to reach the ambient water temperature before retrieving and zeroing it. Zero the depth sensor with the **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** command. You should not change this unless you suspect the accuracy of the depth measurement. For more information on the pressure sensor, see section **Error! Reference source not found.**.

After the tow-cable has been secured to the towing vessel you are ready to deploy the towfish. Once the magnetometer is far enough away from the magnetic influence of the ship (approximately 3 times the length of the vessel) you can start collecting data by selecting a sampling mode using the **1**-**6** commands. Selecting **1** will choose the fastest cycling rate of 0.25 seconds per reading, and **6** will select the slowest of 10 seconds per reading. A rate of 1 reading per second (**3** 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. **Do not expect the Explorer magnetometer (or any magnetometer) to collect useable data when on the deck of the ship or when located nearby to any large ferrous or electrical infrastructure.**

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 on in normal operation.

5 Explorer Commands

Interaction with the Explorer system can be done with single-character commands typed in the main terminal of BOB or any other ASCII terminal program, such as Windows Hyperterminal. A complete summary of these commands is available in the following two tables. The commands are separated into normal commands, and commands that require entry into a special 'diagnostic mode.' This mode prevents accidental activation of features that may disrupt optimal performance of the system.

5.1 Normal Commands

Command	Description
SPC or t	Get Time. Requests current magnetometer time, which is displayed with a resolution of 0.1 seconds in a 24-hour cycle. Magnetometer time is used for determination of cycle timing, i.e. units with the same time value cycling at the same interval will take readings at exactly the same time, regardless of when cycling was initiated. In addition, a unit cycling at a slower interval will be synchronized with a unit cycling at a faster interval, for appropriate readings. For example, a unit cycling at 5000ms will be synchronized with a unit cycling at 1000ms every five seconds. The oscillator used to keep time on the magnetometer has a frequency stability of 1ppm over its entire temperature range, so a magnetometer may gain or lose a maximum of 86.4ms in a day in the worst possible environment.
d or D	Scan sensors. This command provides useful diagnostic information on the state of the towfish at any given time. The first value is the strength of signal currently coming from the Overhauser sensor. When the towfish is idle, this value should be around 7 to 9. The next value is battery voltage, followed by the temperature of the electronics, and then the current depth of the towfish. The last value is the leak sensor status. L0 indicates no leak, while L9 indicates a leak.
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 magnetometer is cycling (taking readings).
f or F	Take a single reading. The magnetometer 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 magnetometer will transmit the data obtained from the reading.
6	Set 10-second cycle time. Puts the magnetometer in a mode that measures magnetic field readings at a rate of 0.1Hz. The magnetometer will continue in this mode until ordered to enter a different mode. After every reading, the magnetic field data will be transmitted automatically.
5	Set 5-second cycle time.
4	Set 3-second cycle time.
3	Set 1-second cycle time.
2	Set 500ms cycle time.

1	Set 250ms cycle time
0 (zero)	Stop cycling. This command will terminate all cycling. The magnetometer 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 depth sensor zero pressure. Use this command prior to survey while the fish 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. 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, and will also allow a cancellation of the command (**x**) or the selection of the factory default slope. The response will report the new slope in mV/m. The factory default is 18.2mV/m.
S	Status. This will display the Explorer serial number, the cycling state, and the state of all relevant settings. If any setting is set to a non-default state, a warning will appear, and also the command that is required to set it back to default.
O (Oh)	Perform environment test. The unit will sweep the entire frequency band searching for noise. If the test fails, there is a source of interference present that must be eliminated for proper operation. Next, the unit will test the magnetic gradient. If this test fails, there is probably some magnetic material close to the sensor that must be removed. If all tests are passed, then the unit's environment is suitable for optimal operation.
y	Auto-tuning off. By default, an optimal tuning value is calculated at the end of 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.
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 response is the step number, 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. This command may be used to turn the RF polarization circuit on or off manually. Expect the towfish current draw to rise to about 70mA if the input voltage is 24V, and if the RF is tuned properly, using the magnetometer sensor as a load.
e or E	Connect/Disconnect Overhauser sensor. When Explorer is in standby, the electronics are electrically isolated from the Overhauser sensor. This command manually connects the sensor to the amplifiers.
k or K	Disable/Enable/Force long deflect. Long deflect is a technique used in

	Explorer magnetometers to boost signal strength in low fields. Explorer will automatically switch to long deflect mode in fields below about 42μT. Although long deflect provides better signal strength, it also shortens measurement time, and it may be beneficial under certain circumstances to disable it. It is recommended to keep this function set to automatic. This command will toggle the long deflect setting between automatic, always off, and always on.
h	Increment hour. Adds one hour to the magnetometer clock.
H	Decrement hour. Subtracts one hour from the magnetometer clock
m	Increment minute. Adds one minute to the magnetometer clock.
M	Decrement minute. Subtracts one minute from the magnetometer clock.
w	Reset seconds. Sets the magnetometer seconds to 0.
W	Reset time. Sets the magnetometer time to 0:00:00.0. This is a very quick way to synchronize multiple units if the absolute time value is not important.
g or G	Retransmit last reading. The last reading that was taken will be retransmitted in the format described later in the manual. In binary mode, this command will dump all readings from the magnetometer's memory buffer, and will clear the memory buffer.
!	Get towfish serial number.
%	Get firmware checksum. The firmware checksum can be used to identify your firmware version when calling Marine Magnetics for technical support. The response will be an 8 digit hex number.
\	Enter/exit diagnostic mode. You will be prompted to confirm. Explorer will stay in diagnostic mode until commanded to exit, or until powered down.

table 5-1: Normal operating commands

5.2 Diagnostic Mode

The following commands are only available in diagnostic mode, which is accessed with the **** command. Since several of these commands can disrupt operation if not used properly, it is recommended to not keep the unit in diagnostic mode during normal operation. In general, diagnostic mode should not be used unless you are instructed to do so by Marine Magnetics technical support.

Command	Description
B	Change baud rate. The baud rate may be changed to 1200, 2400, 4800, 9600 (factory default) and 19200 bps. **WARNING!** This setting will be remembered even after Explorer is powered off. If your terminal is not set to the corresponding baud rate setting, it may appear as though the Explorer electronics module is not functioning.
b	Change data format. See chapter 6 for more information on available data formats.
a or A	Toggle auto-deflect pulse width. Do not adjust this setting unless instructed by Marine Magnetics technical support to do so.
z or Z	Toggle auto-deflect sync. Do not adjust this setting unless instructed by Marine Magnetics technical support to do so.
j or J	Sets long deflect sample proportion. Default is 5 (50%). When long deflect mode is active, decreasing this value will increase the sample time of a measurement, but may result in weaker signal being generated by the sensor.

table 5-2: Diagnostic mode commands

6 Explorer Data Format

Data that is presented by the magnetometer during cycling can appear in one of three formats. An operator can choose between formats using the **b** command in diagnostic mode.

6.1 Standard Format

The Standard data format is the most commonly used, and is usually the default setting when an Explorer magnetometer is first shipped. It is fully compatible with the SeaSPY standard data string. The data string appears as follows:

*YY.JJJ/HH:MM:SS.S F:FFFFFF.FFF S:SSS D:+DDD.Dm L0 TTTms_Q:QQ !!!! CR LF

The first character of each line is always * (ASCII code 42). This leading character is supplied for automated data collection systems that require periodic synchronization with the data stream.

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

Number	Description
Y	Year (time of reading).
J	Julian day (time of reading).
H	Hour (time of reading).
M	Minute (time of reading).
S	Second (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. Anything over 80 is considered an acceptable signal, and anything over 130 is considered excellent.
D	Towfish Depth. The value shown is in meters. The depth sensor can be calibrated using the **P** and **p** commands. (Only available if depth sensor installed)
L0	Leak sensor output, 0 to 9. 0 indicates no leak, and 9 indicates that a leak is present.
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.
Q	Signal quality. This is a two-digit number between 00 to 99. The left digit is a good indication of signal strength, and the right digit indicates how much information was available for measurement.
!	Warning Messages.
CR	Carriage Return (ASCII code 13).
LF	Line Feed (ASCII code 10).

table 6-1: Standard Data Format Description

The data string also contains various letter designators throughout the string (non-italicized letters) to help identify data types (table 6-2).

Letter	Meaning
F:	Total magnetic field reading following
S:	Signal strength following
D:	Depth reading following (+/-)
L:	Leak indicator value following

table 6-2: Letter designators in the data string

6.1.1 Warning Messages

There are four different warning messages that can be displayed in the raw data log by the magnetometer. The warning messages may be summarized as follows (table 6-3). See section 6.1 for the location of warning messages in the raw data log (*'!'* in example string).

Letter	Meaning
W	Weak signal. This message is displayed if the signal strength for the reading is below a threshold value.
G	Gradient condition. In high magnetic gradients, the signal produced by the sensor decays more quickly. This message occurs if the measurement time was prematurely terminated due to a quickly decaying signal. The strength of the gradient can be estimated by observing the measurement time. Note that sensitivity will decrease as the measurement time decreases.
P	Poor reading. This message is displayed if the signal is sampled for too short a time period, for whatever the reason. Expect this message under conditions of extremely high magnetic gradient.
M	Instrument Mistuned. The magnetometer may display this message under extremely poor signal conditions, which is characteristic of poor tuning settings. When this message occurs, the instrument will attempt to retune by executing an initialize tuning procedure, if the auto-tuning feature is enabled.

table 6-3: Warning Messages

6.2 Compact Format

The compact format contains most of the information of the standard format, but with no annotation. It contains 24h time information, but no date and no signal quality value. The compact data format is necessary if interfacing to an Edgetech DF-1000 digital side scan sonar.

The compact data string appears as follows:

**HH:MM:SS.S FFFFFF.FFF SSS TTTT +DDDD.Dm !!!!! CR LF*

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

Letter	Description
H	Hour (time of reading).
M	Minute (time of reading).
S	Second (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. Anything over 80 is considered an acceptable signal, and anything over 130 is considered excellent.
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.
D	Towfish Depth. The value shown is in meters. The depth sensor can be calibrated using the **P** and **p** commands.
W	Warning messages.
CR	Carriage Return (ASCII code 13).
LF	Line Feed (ASCII code 10).

table 6-4: Compact data format description

The warning messages above are identical to those in the standard data format description, summarized in table 6-3. The one additional message is the leak message, the first of the group. If a leak is present, an 'L' message will be visible in this section.

6.2.1 SIS-1000 Compatible Format

The SIS-1000 compatible format contains only magnetic field, signal strength, and pressure depth. It is necessary to switch to this format when interfacing to a Benthos SIS-1000 or SIS-3000 system. Note that this mode is not required if interfacing to a Benthos SIS-1500 digital side scan sonar system.

The SIS-1000 compatible data string appears as follows:

`$ FFFFFF.FFF SSSS DDDD CR LF`

Note that the first character of the SIS-1000 compatible data string is a '$', not a '*' as is the case with the other two data formats.

Letter	Description
F	Magnetic field (nT). If the field value is less than 100,000nT (which is usually the case) there will be a space after the $ sign. If the field value is 100,000nT or greater, the space will be replaced with a '1'.
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. Anything over 800 is considered an acceptable signal, and anything over 1300 is considered excellent. It is identical to the signal strength value in the other data formats, multiplied by 10.
D	Towfish Depth. The value shown is in units of 0.1m. If the towfish depth exceeds 999.9m, an extra digit will be displayed. **Note**: if a leak is detected, this value will consistently read 9999.
CR	Carriage Return (ASCII code 13).
LF	Line Feed (ASCII code 10).

table 6-5: SIS-1000 compatible data format description

7 Interfacing to Side Scan Sonar

An Explorer towfish can be towed simultaneously with a multitude of different side-scan sonar units. figure 7-1 shows the Explorer Side Scan Integration. 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 Explorer must be configured differently depending on the side scan sonar being used. The following table shows the relevant differences between each system.

Side Scan Model	Analog / Digital	Comm	Output Voltage	RS232 Baud Rate	Data String Format
Benthos SIS-1000	Digital	1-way	24-30VDC	9600bps	SIS-1000
Benthos SIS-1624	Digital	2-way	24-30VDC	9600bps	Standard
Benthos SIS-1625	Digital	2-way	24-30VDC	9600bps	Standard
Benthos C3D	Digital	2-way	24-30VDC	9600bps	Standard
C-MAX CM2*	Digital	1-way	24VDC	9600bps	Standard
Edgetech DF-1000	Digital	1-way	40VDC	1200bps	Compact
Edgetech DT-1	Digital	2-way	24VDC	9600bps	Standard
Edgetech 4200	Digital	2-way	24VDC	9600bps	Standard
Edgetech 2000-DSS	Digital	2-way	24VDC	9600bps	Standard
Edgetech 2400	Digital	2-way	24VDC	9600bps	Standard
Geoacoustics 2000	Digital	2-way	32VDC	9600bps	Standard
Klein 3000	Digital	2-way	24VDC	9600bps	Standard
Klein 3000H	Digital	2-way	24VDC	9600bps	Standard

** If the C-MAX CM2 is fitted with a depth sensor, this depth sensor reading will replace the explorer one.*

table 7-1: Side scan parameters by model

Ensure that the side scan sonar is configured to output a voltage within the Explorer's acceptable input range!

7.1 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 Explorer 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 sonar deployed, these types of integrations will almost always be custom-made for a specific configuration or application. Operation of the Explorer towfish is exactly as it would be in a stand-alone configuration.

7.2 Digital Systems

Interface to a digital side scan sonar system involves sending the digital data output from the Explorer towfish to a data input port on the side scan sonar. The side scan sonar'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 Explorer towfish draws power directly from the side scan sonar.

Interfacing an Explorer 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 Explorer 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 Explorer magnetometers, and to several side scan products to allow seamless, trouble-free operation together. Table 7-1 shows the side scan products that are currently supported by the Explorer design, and have been tested by Marine Magnetics. In all cases, a magnetometer interface kit is required from the side scan sonar manufacturer.

7.3 Communication

Some side scan systems provide bidirectional communication with the Explorer. With these systems, the Explorer is controlled the same as in stand-alone mode. Only the baud rate has to be programmed correctly before deployment. For side scan systems that provide only one-way communication, the Explorer must be fully configured before deployment since no commands can be sent down to the towfish after it is connected to the side scan sonar. Data can only be transmitted up from the fish. All settings including sample rate and tuning mode must be programmed with a PC prior to deployment using the patch cable and AC power supply that are shipped with the side scan interface kit.

7.4 Baud Rate

The Explorer baud rate can be configured using the **B** command. Ensure that the Explorer baud rate matches that of the side scan system being used. Note that if the baud rate is not set correctly prior to connecting the towfish to the side scan sonar, no communication will be possible even with a bidirectional side scan system.

7.5 Power

The Explorer Side Scan Integration does not contain any electronics so the output from the side scan sonar must be within the acceptable range for the Explorer towfish (+8 to +40VDC). The Explorer Side Scan Integration contains a 500mA resettable fuse to protect the towfish and side scan sonar from short circuits or faulty cables. If the output current to the magnetometer exceeds 500mA, 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 or the side scan system itself.

7.6 Mechanical Tow Point

The Side Scan Integration consists of a stainless steel interface housing that functions as a tow point. The interface housing is permanently connected to a 10m tow cable that is terminated with a standard Explorer 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 sonar interface cable connects to the top of the bar, and the Explorer interface clips directly to the bar with a clevis pin, through a universal link that allows full rotation in two dimensions. Figure 7-1 shows how to connect a Side Scan Integration to an Explorer magnetometer.

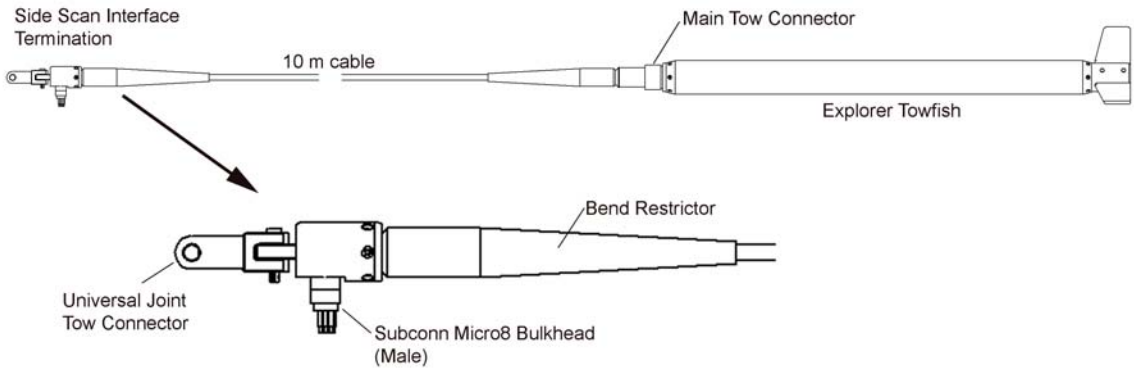


figure 7-1. Explorer Side Scan Integration

8 Towing Depth

Controlling the depth of the Explorer towfish during a survey is essential to obtaining good results. The following factors will influence the depth of the towfish while towing:

1. Survey speed (slower=deeper)
2. Deployed tow cable length (longer=deeper)
3. Weight of tow cable (heavier=deeper)
4. Weight of towfish (heavier=deeper)

The above may seem obvious, but it is important to note that they are the only factors that will affect towfish depth. Manipulation of these four variables is the only way to regulate the depth of the towfish.

9 Inside the Towfish

9.1 Disclaimer

Do not attempt to open the towfish. If you suspect that an internal component of the magnetometer has become damaged, it should be returned to the Marine Magnetics facility for repair. Attempting to open the towfish without direct instruction from Marine Magnetics personnel may result in serious damage to internal components. Marine Magnetics will not assume responsibility for damage done to the magnetometer while attempting to open it. The following diagrams that show the internal detail of the Explorer system (figure 9-1, **Error! Reference source not found.**) are included only for completeness, not as a guide to field service the instrument.

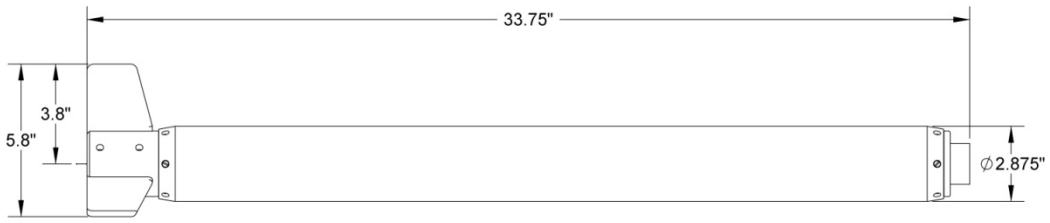
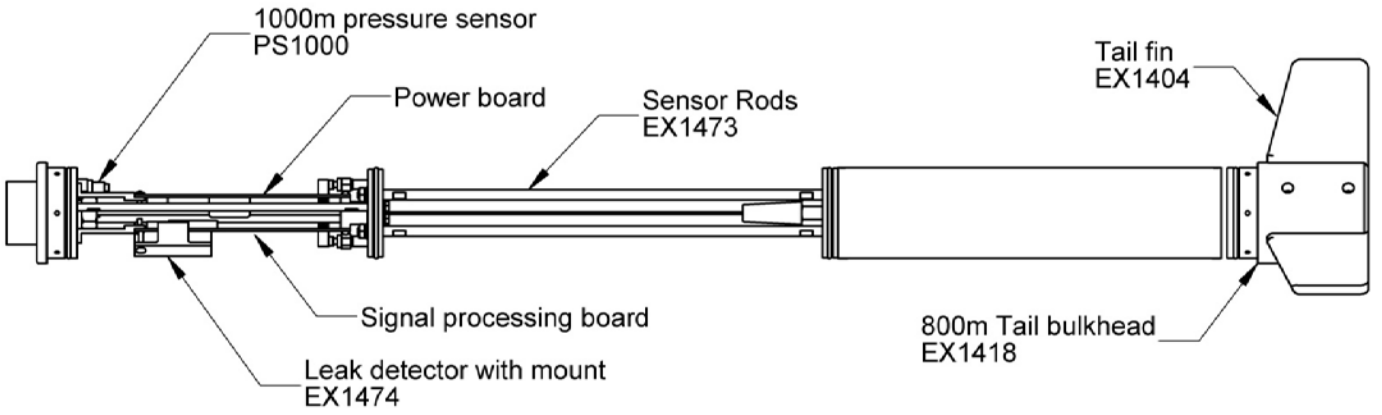


figure 9-1: Standard 300m Explorer towfish dimensions

800m Explorer Internal Structure



Nose and tail bulkhead screws
MS-812
#6-32 x 0.313 flat head
Use brass only

Tail fin screws
MS-518
#4-40 x 0.5 oval head
Use brass only

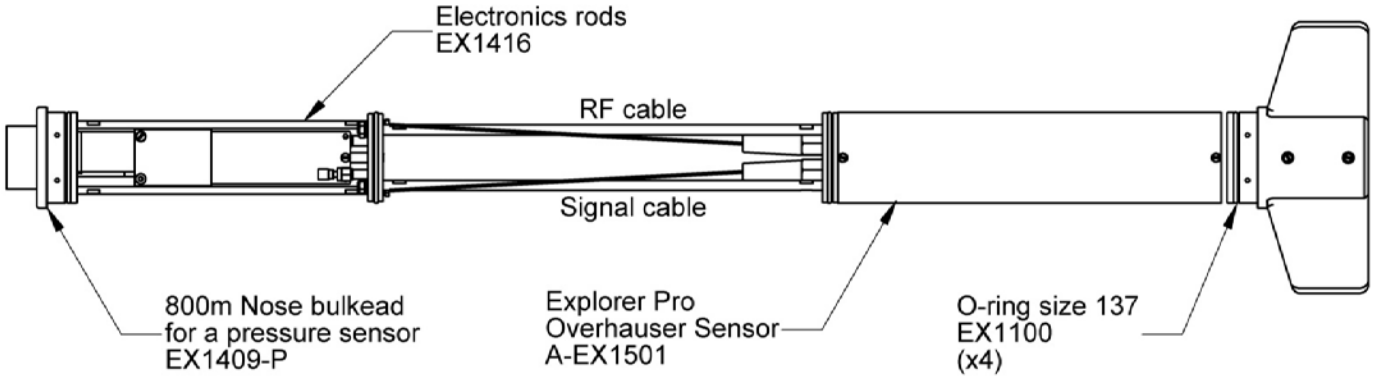


figure 9-2. Explorer towfish internal detail.

Note: Do NOT attempt to open the towfish. Damage to the internal components may result.

10 Maintenance

An Explorer 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 Explorer system will continue to deliver high quality performance with no need for service at the Marine Magnetics facility.

10.1 Deployment and Storage Tips

- 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, making sure that any air pressure inside the connector is completely overpowered.
- 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.
- 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.
- 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.

10.2 O-ring sizes

All O-rings used in the Explorer towfish are made from nitrile-rubber. All sizes are ASTM.

Size	Quantity	Location
137	2	Rear and front towfish housing seals.

table 10-1: Explorer O-ring sizes

11 Troubleshooting

The following test procedure can be used to verify the operation of the Explorer magnetometer system. **Disconnect all cables from the Power Isolator Box (PIB) before proceeding.**

11.1 Power Isolator Box Test Procedure

1) Power the PIB

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

2) Check the status of the *Power* LED

If the ***Power* LED is off** then the PIB is not receiving power. Verify the connection from the power supply to the PIB and from the power supply to the AC power lines. If you are using a battery, check the battery voltage. The PIB 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 PIB.

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

If the ***Power* LED is green** then the towfish is connected. Remove the tow cable from the PIB and start the checklist again. If the tow cable is not connected then the PIB 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 green without a towfish connected, the PIB may be malfunctioning. Contact Marine Magnetics directly for assistance.

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

Identify which COM port the PIB 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.

6) Connect the Explorer to the PIB

Ensure that the magnetometer is connected to the tow cable when the tow cable is connected to the PIB. If everything is connected properly then the *Power* LED should turn solid green and the *Comm* LED will flash green temporarily while the Explorer 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 11-1 for troubleshooting details.

11.2 Explorer Test Procedure

If the Explorer 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

Issue the **t** or **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. The Explorer will respond with the following line.

S:005 B:+24.1V T:+021.7C D:-000.3m L0

The battery voltage should be close to 24V.

3) Zero the depth sensor

If the depth sensor is reading greater than +0.005m while out of the water then you should zero the pressure sensor using the **p** command.

4) Prepare for an environment test

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

5) Perform an environment test

Issue the **o** (oh) command to perform an environment test. If it passes, you should see a message similar to the following.

Initiating Self-diagnostic
Amp test: 193 – Passed
Initiating Self-diagnostic
Noise Test: 000 0367 – Passed
Noise Test: 001 0351 – Passed
Noise Test: 002 0348 – Passed
Noise Test: 004 0409 – Passed
Noise Test: 008 0485 – Passed
Noise Test: 016 0460 – Passed
Noise Test: 032 0978 – Passed
Noise Test: 064 0634 – Passed
Noise Test: 128 0732 – Passed
Checking gradient – Passed

If it fails one of the noise tests, try the test again, as there may be some ambient noise interfering with the sensor. If it continuously fails the test, move the Explorer to a different location and try the test again, as there is too much interference in its current location.
When the Explorer passes an environmental test, it is in a location where it should be able to take good readings of the magnetic field.

6) Start Sampling

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

**06.327/15:16:47.0 F:055294.465 S:192 D:+000.1m L0 0965ms Q:99*

Notes:

- The value of the F: field may differ significantly when tested at your location.
- The value for S: should be between 130 and 200 for good quality readings.
- The value for the ms reading should be 965 when F: is greater than 42000 and it should be 465 when F: is less than 42000.
- The value of Q: should always be 99 if the Explorer is taking proper readings.

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

11.3 Troubleshooting Specific Issues

The following table (table 11-1) addresses specific issues that may occur. For more details or other issues, please contact Marine Magnetics directly.

Symptom	Possible causes	Solution
PIB *Power* LED is off	• Insufficient power is being supplied to the PIB	• Verify the connection from the power supply to the PIB and from the power supply to the AC power lines. • If you are using a battery, check the battery voltage. • The PIB 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.
PIB *Power* LED is red	• Towfish is not connected • There is a short in the cable or in the Explorer • Water is present in the circuit	• Ensure that the tow cable is properly connected to both the PIB and the Explorer towfish. • Examine the cable for cuts or leaks and inspect the connectors for damage or shorts. • Inspect the main tow connector on the tow cable and magnetometer. • Using an ohmmeter, verify that none of the cables or connectors are shorted.

No response from the towfish	• Error in the equipment setup	• Make sure all cables are connected and the *Power* LED on the PIB is green. • Make sure baud rate and communication protocol of the terminal software are set correctly. • Ensure baud rate of the COM port in Windows is set correctly.
Communication issues	• Insufficient voltage • Damaged cable	• Check the voltage going to the towfish. • Inspect all cables for damage.
Poor magnetic field readings	• External noise on the sensor • Power supply amplifiers are adding noise to the system	• Move the towfish to a different location and run the environment test again. • Avoid interferences such as radio waves, train tracks, on-board generator. • Use batteries instead of AC power.
Towfish leak	• Explorer housing damaged from impact • Explorer sensor bottle damaged from impact • Damaged O-ring • Maximum depth rating exceeded for Explorer	• Shutdown towfish. • Retrieve towfish immediately. • Contact Marine Magnetics directly for assistance.

table 11-1: Troubleshooting specific issues

11.4 Electrical Specifications

The following table shows the expected measurements under working conditions. If you are experiencing abnormal results then consult table 11-1 for troubleshooting tips.

Location	Parameter	Min	Typ.	Max	Units
PIB	Input Voltage	9	24	28	V
@ 24V	Input Current (no towfish)	37	39	41	mA
	Output Voltage	23.5	24	24.5	V
	Output Current	-	-	1	A
Side Scan Integration	Input Voltage	8	24	40	V
	Output Voltage	same as input			V
	Output Current	-	-	500	mA
Explorer	Input Voltage	8	24	40	V
Cycling	Input Power	-	2	2.7	W
Standby @ 24V	Input Current[1]	16	18	20	mA
Cycling @ 24V	Input Current[1]	70	90	100	mA
Tow cable	Resistance (along conductors -power)	-	22	-	mΩ/m
	Resistance (along conductors -comm)	-	56	-	mΩ/m
	Resistance (between conductors)	10	∞	-	MΩ

Notes:

1) 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.

table 11-2: Electrical specifications

12 How to Reach Us

If you encounter a problem using your Explorer 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

13 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 *Explorer* should not be opened or repaired in the field, unless instructed to do so by Marine Magnetics technical support staff.

Opening the *Explorer* without Marine Magnetics technical support approval will render the warranty null and void.

13.1 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.

13.2 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.