

PROTON 4
MARINE MAGNETOMETER
REV 0609
OPERATION AND
MAINTENANCE MANUAL



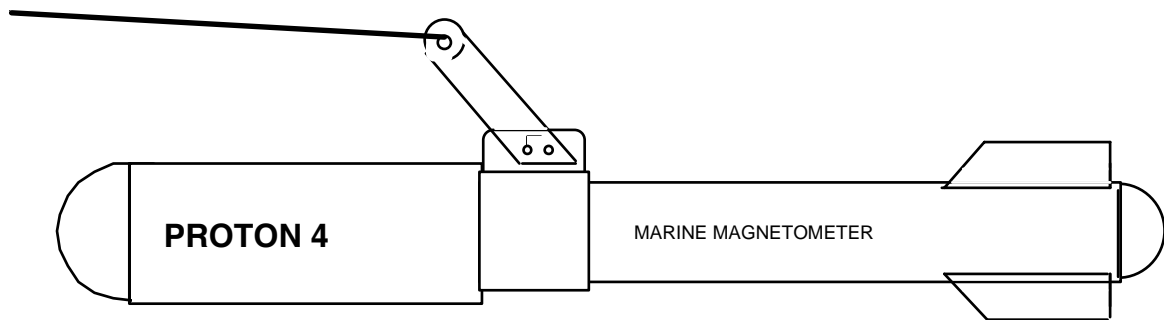
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DO NOT

- Operate the P4 until liquid (charcoal lighter fluid) has been added to the sensor housing; damage can occur to the sensor coils (see page 25).
- Expose cable connector to salt water.
- Bend tow line sharply.
- Let Fish sit in hot sun for prolonged periods.

DO

- Always operate unit on land before taking in water at a new location (to be sure Fish is tuned correctly).
- Operate with two fully charged 12 v batteries.
- Verify readings--by numerous passes--before diving.
- Use only non-ferrous metal on the Fish (screws, etc.).
- Use #12 wire (or larger) to extend battery cable if needed.
- If you are using the UA2 altimeter, be sure the sync cable from the Proton 4 control box is connected to the back of the UA2. If the UA2 is allowed to free-run it will interfere with the Proton 4 readout (readout jumps around).
- Be sure to ground the black power wire (-12). This helps to reduce outside electrical noise which can cause the readout to "jump around". See page 28.

PROTON 4 SPECIFICATIONS

DIMENSIONS/WEIGHT:

- Fish 52' L x 6" Dia 48 lbs
- Control Box 13"Lx13"Wx6"H 5 lbs
- Tow Line 75"Dx150/300' 30/60 lbs
- Carrying case 53"Lx15"Dx13"H 25 lbs
- Total Shipping 53"Lx15"Dx13"H 120/150 lbs

PERFORMANCE/DESCRIPTION:

- Sensitivity (adjustable) resolves 1-20 gamma
- Maximum detection distance 1500' plus
- Cycle time (adjustable) 2-4 seconds
- Tow speed 1-10 MPH
- Input voltage 24 vdc
- Power consumption 40 W

MATERIALS/COLOR:

- Fish High impact, stainless/yellow
- Control Box High impact case, black
- Cable 8 conductor polypropylene/yellow

OPTIONS

- 300 ft. cable
- Chart recorder (printer)
- GPS/Loran interface
- GPS receiver
- Altimeter
- RS232 Computer interface
- Charting Software for PC

PROTON 4 DETECTION RANGES CHART

<u>OBJECT</u>	<u>GAMMA CHANGE (up or down) NEAR RANGE</u>	<u>GAMMA CHANGE (up or down) FAR RANGE</u>
1 gal can		2 gamma 12'
5 gal can		2 gamma 18'
55 gal can		2 gamma 45'
Sm. Plane	25 gamma at 20'	2 gamma at 50'
1 ton iron	40 gamma at 30'	2 gamma at 80'
6" pipeline	200 gamma at 20'	2 gamma at 100'
12' pipeline	350 gamma at 20'	2 gamma at 175'
Lg. anchor	500 gamma at 50'	2 gamma at 200'
Med. ship	1500 gamma at 100'	2 gamma a 1000'
Lg. ship	2000 gamma at 100'	2 gamma at 1500'

The above chart shows the Proton 4 approximate detection range for different targets. The Proton 4 has a sensitivity of one gamma; that is, it will detect a change of one gamma. Each one gamma change will change the digital readout one digit.

CHART (above) EXAMPLE:

As the Proton 4 fish approaches a small plane, you can expect a one gamma change at 65-75' (the digital readout would change one digit, ie: from 48,240 to 48,239). At 50' distance, another one gamma change would take place (ie: 48,238 on readout). As the fish gets closer, the readout continues to decrement. At 20', you can expect the readout to be at 48,215 (total change of 25 gamma). As the fish passes next to the plane the digital readout could be several hundred digits lower. If the target was 1 ton of iron, the readout could show a change of 2,000. As the fish goes past the target, the readout would walk back to normal (48,240) in reverse of the above sequence.

As a target is approached, the gamma reading can change up (increment) or down (decrement) depending on what is happening to the magnetic field in the area. It is not unusual, when making many passes in different directions over a target, to find some passes incrementing the readout number and other passes decrementing the number. In most cases, when you approach a target, the gamma number will drop as shown in the example above.

MAGNETIC DEVIATION CHART (next page):

The chart on the next page is a magnetic deviation chart that shows the approximate amount of magnetic deviation, or change, that could be expected for different size iron targets at different distances. The chart is used to determine the distance between grid lines (boat passes) when searching for a known target.

It is desirable to set the grid distances to have at a minimum of a 10 gamma (10nT) change in the magnetometer readout when the target is located. Some operators set the grid pattern distances to insure a minimum of a 20 g change to be sure they do not miss the target.

The chart assumes that the mag is being towed a few meters off the bottom. If the mag is being towed 10 meters off the bottom, then the grid lines must be much closer than the chart indicates. The smaller the target, the closer the mag must be towed to the bottom.

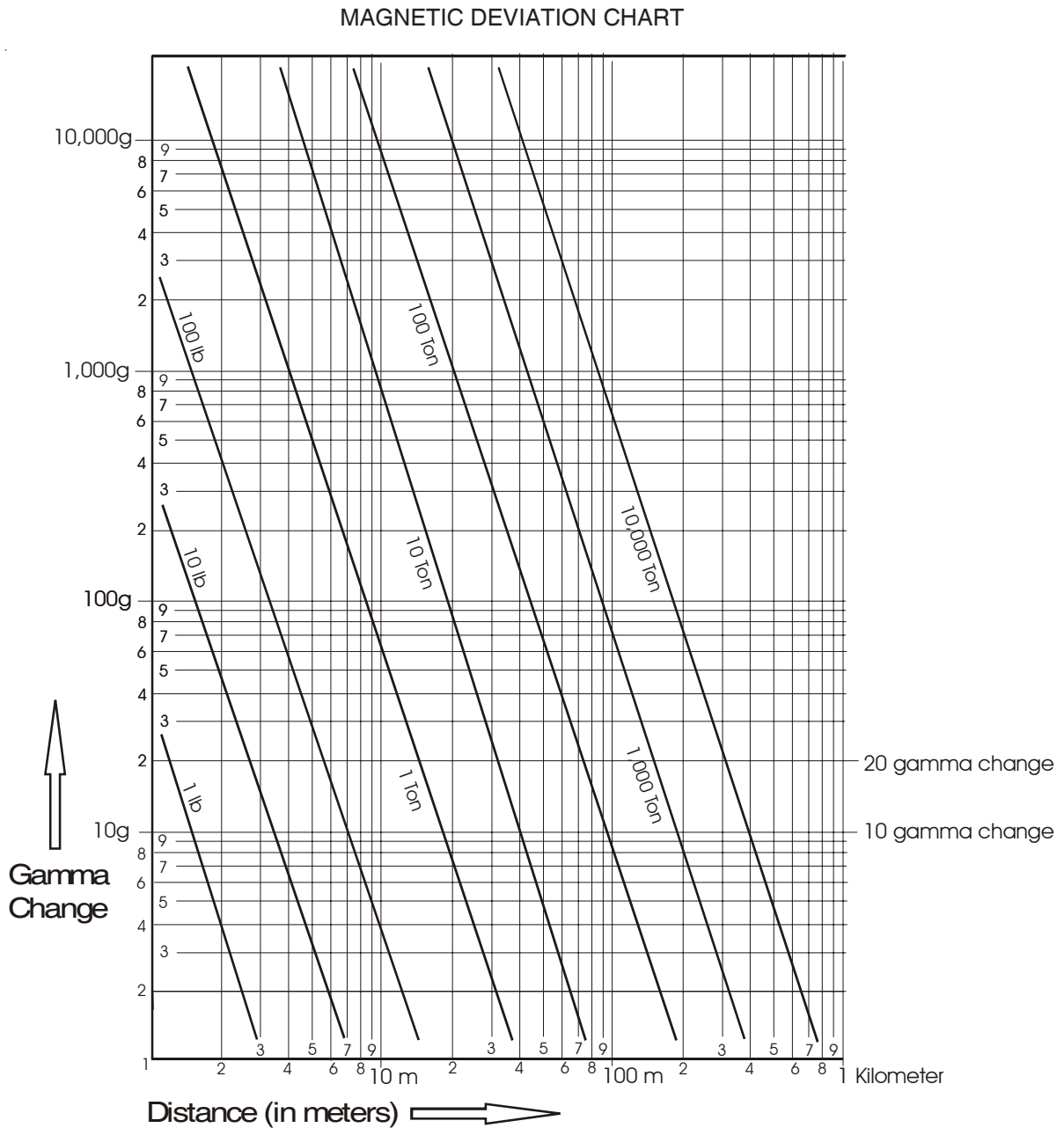
An actual example of a search pattern that was set up:

A 6.5 ton anchor with 9 shots (total weight was 37 ton) was lost in a river. Because of it's value (a must find) a grid pattern was set up to insure a minimum of a 20 g readout change when the mag went past the target.

MAGNETIC DEVIATION CHART: (continued)

The chart below shows that a 37 ton iron target will produce a 20 g change approximately 45 m away (146 feet). The grid lines were set up 90 m apart.

If the target had not been found, the search pattern would have been repeated except the grid lines (boat passes) would have been in-between the original grid lines. This would result in a pass every 45 m (first pass plus the second pass).



PROTON 4 MAGNETOMETER

INTRODUCTION

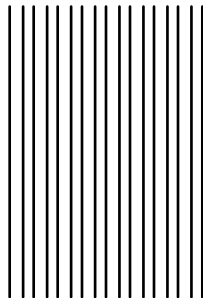
The PROTON 4 Magnetometer is a precision electronic instrument that measures the strength of the earth's magnetic field. Once the magnetometer is set up in an area, it will inform the operator of the strength of the earth's magnetic field in that area (in gammas). More importantly (for our application), if anything is brought into that area that alters the earth's magnetic field, it will change the readout of the magnetometer. For an object to alter the earth's magnetic field, it must be constructed of a ferromagnetic material (iron content). Any material that a magnet is attracted to will alter the earth's magnetic field and therefore can be detected by a magnetometer.

The earth's magnetic field varies in intensity over the surface of the earth (see world map in box).

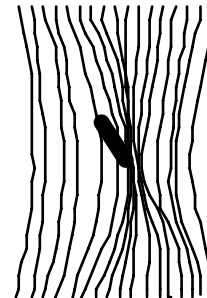
Note: A world map showing the gamma readout in all areas of the world is also available on-line at <http://geomag.usgs.gov/charts> Select the PDF "Total Intensity World" and use the zoom tool.

At the poles, the field is concentrated and therefore has a high intensity. A magnetometer would read in the 61,000 gamma area at the poles. At the equator, the field is quite weak. A magnetometer would read in the 24,000 gamma area at the equator. In any given area of the world, the field is fairly even. If an iron object is introduced into the area, the lines of force are disturbed. The amount of disturbance is a function of the mass of the object.

EARTH'S MAGNETIC
FIELD - NORMAL



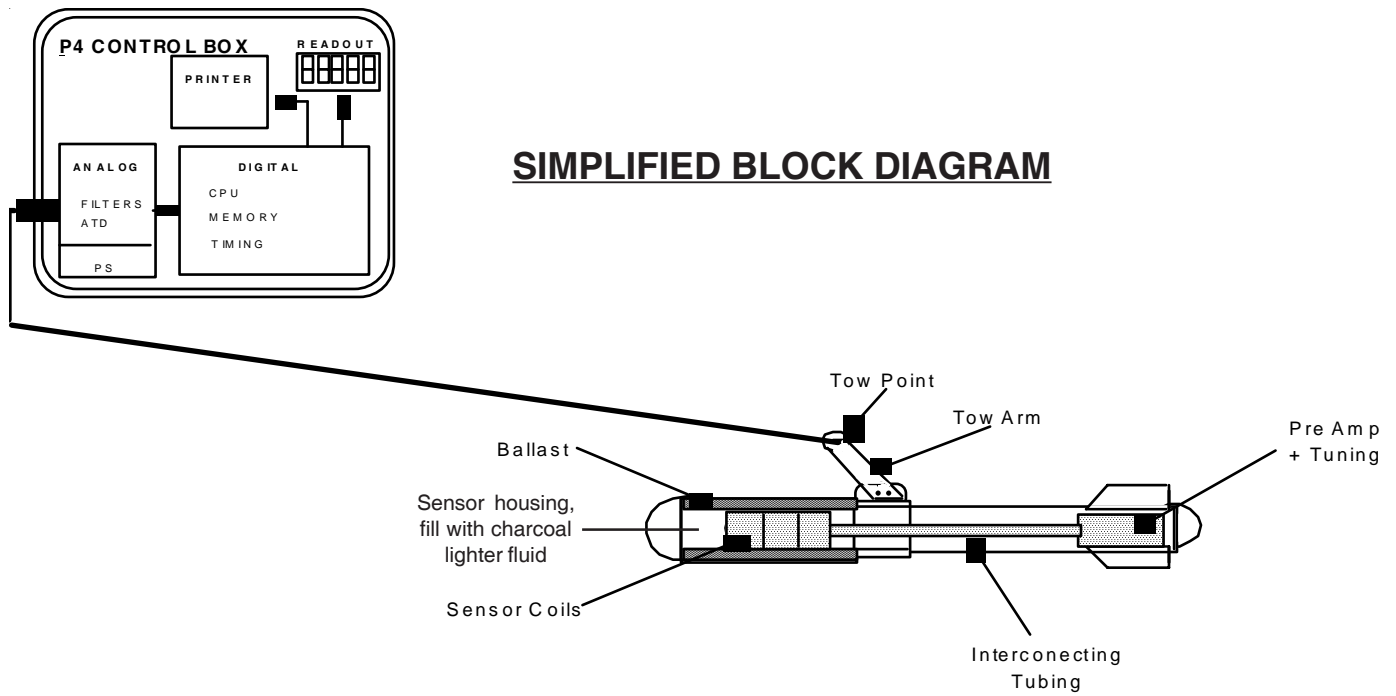
EARTH'S MAGNETIC
FIELD - IRON OBJECT



Over the past 35 years, almost every major wreck found was done so with a magnetometer. The metal-hulled ships and barges are, of course, easy targets and can be detected from hundreds of feet away. The Spanish galleons laden with gold and silver (metals not detectable by a magnetometer) were found by the magnetometer detecting the ships' anchors or ballast stones (magnetite was often used as ballast). One of the largest finds to date was a galleon off Florida, found 35 years ago, carrying four hundred million dollars worth of gold and silver. The wreck was found with a proton magnetometer (detected the anchor).

THEORY OF OPERATION

The sensor, in the Fish, contains charcoal lighter fluid (ships empty from factory, see page 25) which is rich in protons (nuclei of hydrogen atoms). The protons act like small bar magnets and align themselves parallel to the earth's magnetic field (like a compass). Several coils of wire are in the liquid and when a voltage is applied to it (called POLARIZATION or POL TIME), the protons align to this stronger field. After several seconds, the voltage is removed and the protons swing back to align to the earth's magnetic field.

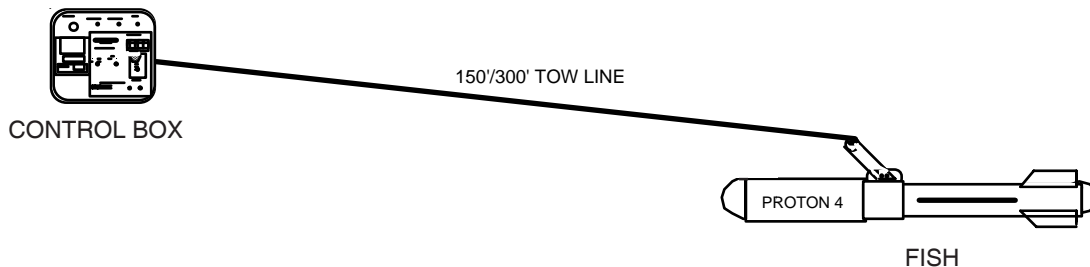


The protons "swinging back" induce small voltage pulses in the coils which are amplified by the Fish and sent across the cable to the Control Box. To optimize the amplifier in the Fish, the amplifier is "tuned" (by a switch) for the frequency (gammas) of the pulses in your area (see world map in shipping box). The tuning is very broad. Once the fish is tuned it will operate over a very large area (+/- 1500 gamma).

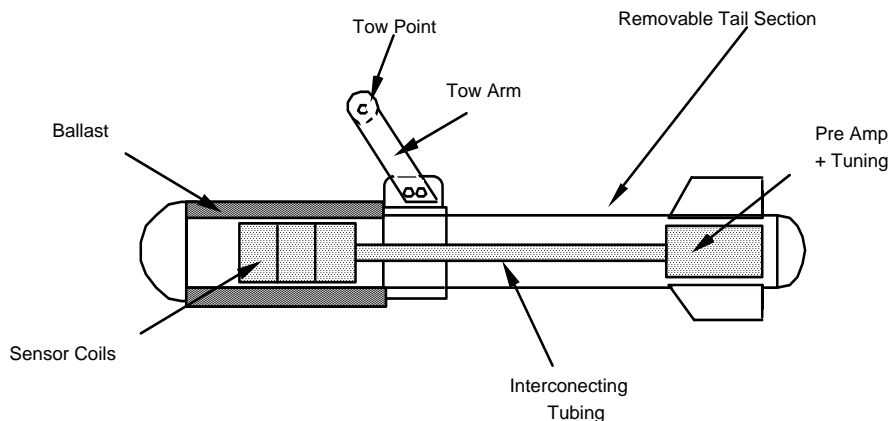
When the Control Box receives the signal from the Fish, it also filters the signal and sends the signal to the counter. The counter counts the pulses, converts them to gammas, and sends the results to the READOUT. The READOUT stores and displays the count. The process is then repeated (called "cycling"). Two seconds of POL TIME (voltage applied to sensor coils) followed by one quarter second of READ TIME (Control Box counting pulses). As long as the count remains the same for each cycle, the READOUT would never change. If the count changes with each cycle, then the READOUT would change every two and one quarter seconds.

SYSTEM BREAKDOWN

The PROTON 4 is a Proton Magnetometer which consists of a FISH, TOW LINE, and CONTROL BOX.



FISH - The FISH is made up of a 30" long 4" PVC tube and a 20" long 6" PVC tube. The 6" tube is filled for ballast and to isolate the sensor head (Proton Bottle) from salt water.



The 4" tube contains the Sensor Coils and the Pre-Amplifier. The Pre-Amplifier contains a 10 position tuning switch which tunes the Fish to your area.

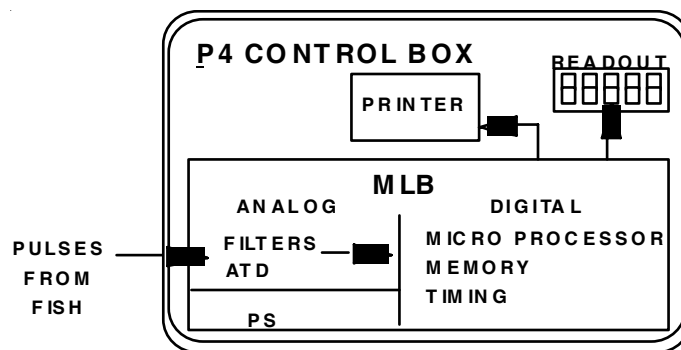
The Fish must be capable of being tuned from 24,000 to 61,000 gammas (see world map). To optimize tuning, a ten position binary switch (100 different combinations) is used to cover the full range of gammas. Each switch position covers a large area, and the position that covers your area has already been selected at the factory (this will be explained later). See P6 on page 19 for more details on tuning.

TOW LINE - The 150' (300'/500'/1000' options are available) Tow Line consists of a multi-paired cable and coax which is the core of a braided polypropylene line. The combination results in a highly abrasion-resistant tow line. One end of the Tow Line is wired into the Fish, and the other end plugs into the Control Box. The Tow Line is marked (black tape) every 50' to aid you in determining how much line is out (see chart below).

<u>FROM FISH END</u>	<u>BANDS FOR 300'</u>	<u>BANDS FOR 500'/1000'</u>
50'	One band	
100'	Two band	One band
150'	Three bands	
200'	Four bands	two bands
250'	Five bands	
300'		Three bands
400'		Four bands
500'		Five bands
600'		Six bands
700'		Seven bands
800'		Eight bands
900'		Nine bands

To avoid any damage to the cables, do not tie the Tow Line in a knot or make any sharp bends with it (do not tie it off on a cleat).

CONTROL BOX - The Control Box receives the signal (pulses) from the Fish, filters the signal, and counts the pulses. After the pulses are counted, it stores the results and displays the count on the five digit LCD readout. The Control Box contains a single main logic board.



MAIN LOGIC BOARD (MLB)

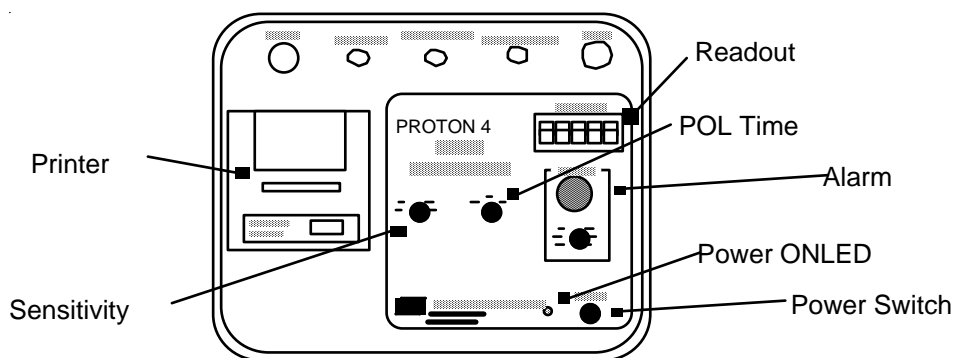
The MLB is divided into three sections; analog, digital, and power supply.

The analog section receives pulses from the tow fish, filters and amplifies them, digitizes them and sends them to the digital section for processing.

The digital section computes the gamma count and sends it to the readout board. The digital section contains the micro processor and memory circuits which control the overall timing of the system. The digital section also controls the optional printer, Loran C/GPS input, and RS232 computer interface.

The power supply section provides the proper voltages for the entire system.

In addition to the logic board, the Control Box contains switches and indicators on the front panel.



POWER SWITCH - When turned on, the 24 volts from the boat/car battery feeds the Power Supply section on the Analog board. The green indicator just to the left of the switch will illuminate.

POL TIME SWITCH - A three position switch that allows the operator to determine the length of Polarization Time of the sensor coils. Pol Times of 2, 3, or 4 sec's can be selected. The POL switch determines how often the unit cycles. Because the boat is moving, we want to take readings as often as possible, so we want to Pol as quickly as possible. This switch is normally used in the 2 second position.

SENSITIVITY SWITCH - A four position switch to allow adjustment of the sensitivity of the unit. Since magnetometers can generate 2-3 gammas of noise while being towed, it is not always desirable to operate at its maximum sensitivity. Also, once a large target is detected, you may want to turn down the sensitivity to enable you to more easily pinpoint the target.

- G1 - A one digit change indicates a one gamma change. Most sensitive position, used to locate small targets. Best position if readout is steady (not jumping around).
- G5 - The gamma reading is divided by 5 before it is displayed. A one digit change in the readout indicates a five gamma change. More stable than G1, used for most mapping operations if in noisy area.
- G10 - The gamma reading is divided by 10 before it is displayed. A one digit change in the readout indicates a ten gamma change. Used in pinpointing targets or when you are looking for a large target in a small area.
- G20 - The gamma reading is divided by 20 before it is displayed. A one digit change in the readout indicates a twenty gamma change. Used in pinpointing large targets.

If you were in Miami, Florida area, you would get an approximate reading (see map) of:

- G1 = 49,138
- G5 = 9,827
- G10 = 4,914
- G20 = 2,457

If you were in the Miami area approaching a large ship:

<u>SEN Setting</u>	<u>2000' away</u>	<u>1000' away</u>	<u>900' away</u>	<u>800' away</u>	<u>100' away</u>
G1	49,138	48,984	48,979	48,963	46,533
G5	9,827	9,797	9,796	9,793	9,307
G10	4,914	4,898	4,898	4,896	4,653
G20	2,457	2,449	2,449	2,448	2,327

READOUT - A five-digit LCD READOUT which displays the gamma count of the signal from the Fish. If the magnetic field that the Fish is passing through is different than the area the Fish just came from, the frequency of the pulses (number of) will change and the READOUT will change. This change can only occur after the one quarter second READ TIME. You will see the change after the readout flashes blank.

ALARM - The audio alarm will sound if the gamma reading changed, between the previous and the present reading, beyond the amount selected with the switch. The Gamma Change switch determines the amount of change that must take place before the alarm goes off. The audio alarm circuit only looks at two consecutive readings. The alarm looks at actual gamma change and not the readout change.

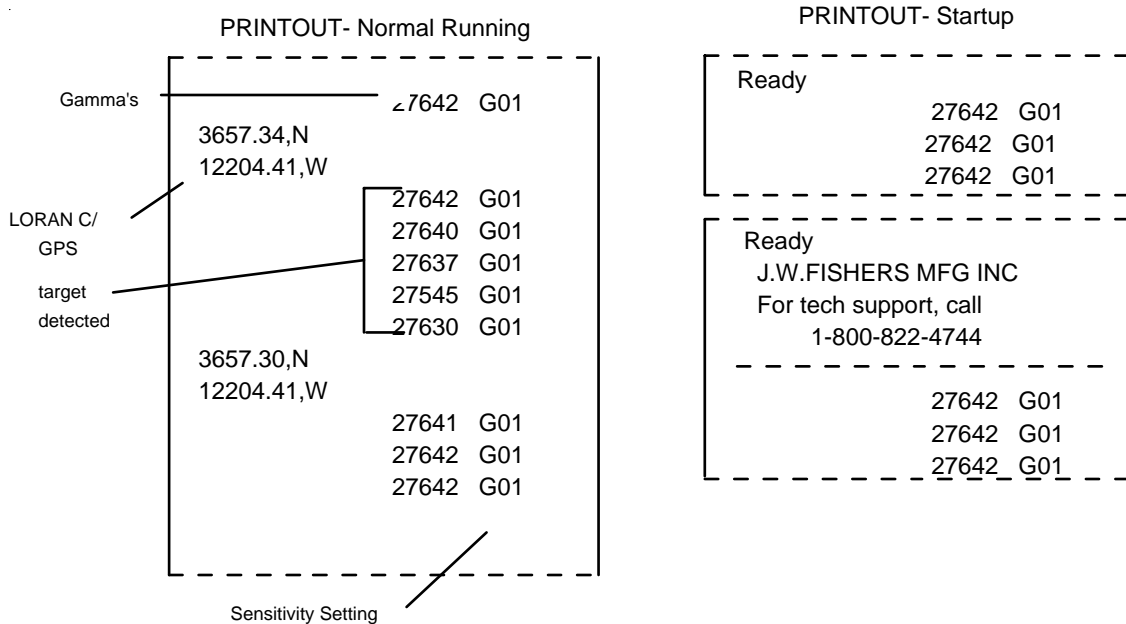
CABLE PLUG - The Tow Cable plugs into this socket. The Tow Cable should not be plugged or unplugged while the unit is running. Protect this plug from water at all times. When not using, the plug should be placed in a small plastic bag.

UA2 SYNC PLUG - If a UA2 altimeter option is installed on the Proton 4, a cable must be connected between the UA2 and the Proton 4 control box. This cable enables the UA2 to operate with the Proton 4 without causing interference (Readout jumping around) to the Proton 4.

INPUT POWER CABLE - Extending from the rear of the Control Box is a 15-foot power cable with a red and black clip on the end. This cable connects to a 24 volt (two 12 v batteries wired in series) source (car type battery). The red clip connects to the (+) terminal and the black clips to the (-) terminal of the second battery. The green wire with the red/black clip connects to the intersection of the two batteries. See next page for connecting batteries. **DO NOT** extend the length of the battery cable unless you use a very heavy (#12 wire) extension. To reduce the possibility of noise interference from the boat motor the boat's 12 v battery should not be used as one of the batteries. The magnetometer should be powered from its own batteries. A fully charged car battery will last 8-10 hrs before recharging is necessary.

OPTIONS

PRINTER - Prints out the gamma reading, as shown on the display, once every cycle. The Sensitivity switch setting on the Control Box is also printed out after each gamma printout (on the same line). After every fifth gamma printout, the system checks to see if a LORAN C or GPS receiver is plugged into the P4 control box; if it is, the position coordinates are also printed out. The printer is normally on-line when the system is powered up and will print "Ready" followed by the company name and phone number. To switch the printer "off-line" (cease printing), press the left side of the printer's rocker switch. To resume printing, press the right side of the printer's rocker switch. It is important to note that the printer's memory continues to store readings when it is switched off-line. These stored readings will be printed out when the printer is switched back "on-line". To avoid printing stored readings, turn off the P4's power switch for 5 seconds. This will clear the printer memory. When the P4's power switch is turned on, the printer will resume normal operation.



ALTIMETER - The Altimeter mounts on the bottom of the Fish and informs the operator how far off the bottom the fish is towing. The Altimeter's readout shows the distance in feet. See Altimeters manual for operating instructions.

LORAN C/GPS - When a Loran C or GPS interface cable is plugged into the Proton 4 Control Box the printer will print out the position coordinates. The position coordinates will also be sent to the optional RS232 computer interface, if equipped. See P2 (page 17) for proper wiring of a 0183 interface from a Loran C or a GPS receiver to the Proton 4. See your Loran C/GPS manual for receiver operating instructions.

RS232 COMPUTER INTERFACE - Enables the gamma readings and LORAN C/GPS coordinates (when connected) to be input to a data recorder or computer. The information can be used by the computer for magnetic anomalies mapping or simply for logging information. See Procedure P11 for cabling and signal specifications.

PC COMPUTER SOFTWARE - This software package will allow the Proton 4 to output it's readout information directly to a computer for real time viewing, printing, or storage. The software will display the mag readout, GPS or LORAN position, compass heading, and boat speed with full color graphics. A window on the right hand side of the screen will show the last 24 readings from the Proton 4, updated every 2 seconds. Also shown will be a strip chart graphic display of the last 5 minutes of readouts. The mag readout data can be stored on a disk or hard drive and played back at any time.

OPERATION

Do not operate the unit until the sensor housing is filled with charcoal lighter fluid.

Operation of the Proton 4 is extremely simple. It will operate month after month without any adjustments once the unit is tuned. Once you have tuned for an area, if you change areas (more than 1,500 gammas), the unit should be checked for proper tuning before going out on the boat (always tune the unit on land, whenever possible, before heading for water). Generally, you would have to travel hundreds of miles (north or south) before tuning would have to be changed, but test it on land to be sure.

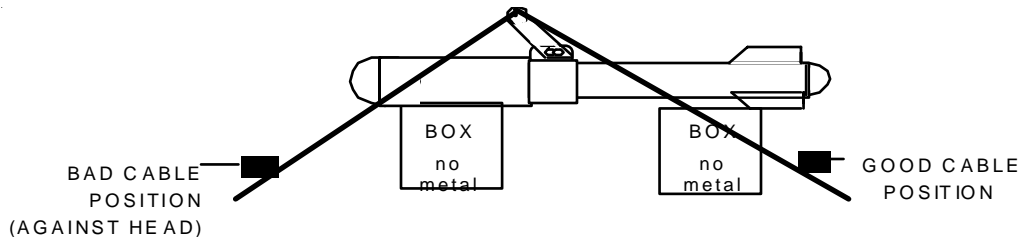
Before your unit was shipped from the factory, the fish was tuned to the gamma reading shown on the map for your area. The gamma setting is written on a tag connected to the outside of the fish. Check the map for the expected gamma reading in your present area, and if it agrees with what is written on the tag (+or- 1,500 gamma) then there is no need to change the tuning for your present area. Simply checkout the system in the field (see below).

If you need to tune the fish, but are unable to test the system (as decried below) at this time, and want to check out the unit, see procedure P3 on page 25. P3 is a procedure to check out the system from inside of a building.

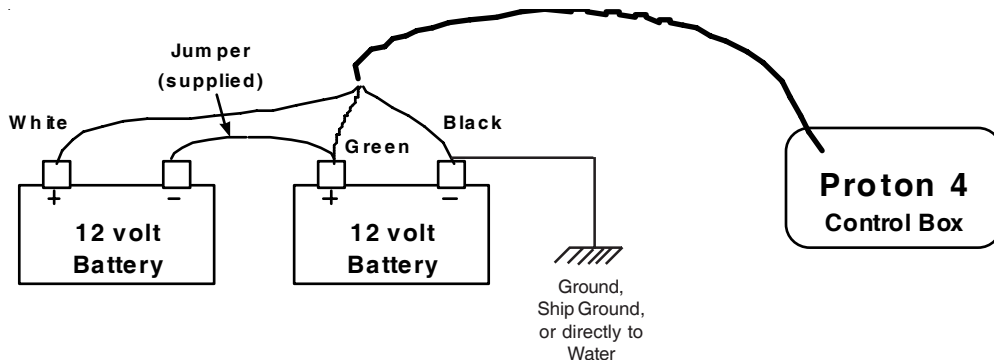
TUNING AND CHECKOUT - CRITICAL!!!

Select an area, outside the city, that is free of power lines and buildings (at least 300' away) and away from any large metals (junk cars, dump, etc.). The unit will not work in a city, or in areas saturated with metal. The unit may not work in a park or field that is located in a city.

Position the Fish 1-2 feet above the ground, but parallel to it (use two cardboard boxes -- be sure there are no metal staples in the boxes).



CABLING: String out the Tow line so the Control Box can be positioned approximately 50-100' away. Do not allow the cable to pass next to the head (keep the cable at least one foot away from the head), and do not coil leftover cable next to the head. Plug the cable into the Control Box and connect the power cable from the Control Box to two fully charged 12 volt batteries. See drawing below for proper battery hookup (grounding the -12 volts helps to reduce noise which gives a steadier readout).



CONTROL BOX TUNING AND OPERATION:

1. Set SENSITIVITY switch to G20.
2. Set Pol Time to 2 sec.
3. Turn off Gamma Change alarm.
4. Turn off printer.
5. Turn on "Power On" switch.

When the "Power On" switch is turned on, the following sequence should take place:

- Power light comes on (immediately).
- Random numbers displayed on LCD readout display.
- Delay (internal checkout) for 10 sec.
- Display update with first reading.

During the two seconds of polarization, a voltage is being applied to the sensor coils. At the end of polarization, the following takes place:

- The LCD readout goes blank during READ time.

During READ time, the pulses are coming from the Fish and are being counted by the Control Box. At the end of the 1/4 second READ time:

- READOUT is updated with the new pulse count (gammas divided by 20).
- Polarization (2 seconds) takes place once again.
- After a few cycles the readout should be steady (may slowly drift over time).

If everything is okay, the unit should continue to cycle (POL on for 2 seconds, READ on for 1/4 second (LCD readout goes blank)); until the Power switch is turned off.

To insure the unit is properly working, have a second person approach the fish with a gallon size steel can.

- When the can is within 6' of the head of the fish the system should start seeing the can (the numbers in the readout should start down). As the can is moved closer to the head the numbers should continue to go down.

Put the sensitivity switch in the G1 position. This is the most sensitive position, the position you would like to normally operate the Proton 4. However, due to outside electrical noise, when the unit is out of the water, you may not be able to operate in this position. When in the G1 position:

1. The readout is displaying gammas and the number should be approximately what the map indicates for your area.
2. The readout will jump around +/- 1 or 2 due to outside noise. If the numbers jump around excessively (15 to 20 gamma) then the fish needs to be tuned or the electrical noise in the area is just too noisy to operate in the G1 position.
3. The number in the readout will slowly drift (up or down) while the sensor coils and fluid temperature stabilize.

NOTE: If any of the above sequence does not take place, see TROUBLESHOOTING in the back of this manual or call the factory 800-822-4744 or 508-822-7330.

TUNING - CRITICAL!!

Before your unit was shipped from the factory, the fish was tuned to the gamma reading shown on the map for your area. The factory adjusted gamma setting is written on a tag connected to the outside of the fish. Check the map for the expected gamma reading in your present area.

The tuning of the fish is very broad. Once tuned for the gamma reading in your area, it will operate over a very wide area (+/- 1,500 gamma). However if it is not properly tuned the readout will "jump around".

Note: on land, even a properly tuned fish will not provide a steady readout if it is in an electrically noisy area. The Proton 4 fish is tuned by a switch located in the preamp housing in the rear of the fish. To gain access to the preamp housing the tail section of the fish must be removed (four screws).

To tune the fish to your area:

1. Remove the four screws in the tow collar that holds the tail section to the tow collar (see Procedure P4 in the back section of this manual).
2. To gain access to the preamp board and tuning switch, remove the four screws from the faceplate on the front of the preamp housing (see Procedure P5 in the back section of this manual).
3. Refer to the large world map that came with your system and determine the normal gamma reading in your area (ie: Miami, Florida is 47,500 gammas).
4. Locate the 10 position tuning switch and jumper (J1) on the preamp board, and using the chart on the next page tune the preamp board by turning on (1) or off (0) each of the 10 switches and setting jumper (J1) on or off . Take care not to damage the board.
5. When reassembling the preamp housing be sure the o-ring is in place and do not over-tighten the four screws on the faceplate.

NOTE:

- The tuning switch can be changed while the unit is running.

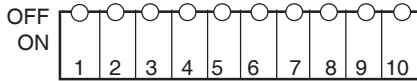
While the unit is running watch the digital readout for stability. The readout may jump around +/- 2 or 3 digits (in G1). This is not unusual when operating out of the water (the readout will be more stable underwater because there is no outside electrical noise underwater). If, however, the readout jumps around 5 digits or more, refer to the chart on the next page and select the next higher and then lower gamma reading. Change the Fish tuning according, looking for the most stable digital readout. It is normal for the readout to slowly drift up or down while the temperature in the fish sensor coils and fluid stabilize.

READOUT: Once the unit is cycling the frequency displayed in the readout should be "steady". The actual frequency that is displayed may be somewhat different from the map, but this is not important. What is important is that the READOUT is steady so when a change does occur you know a metal object caused it. If you are using the unit on land and in a noisy area (RF noise from CB's, radio stations, power generating plants, etc.) the READOUT may jump around somewhat. Mags always run quieter in the water - no interference except what might come from your boat.

PROTON 4 FISH TUNING

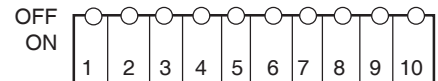
9-20-00

10 POSITION TUNING SWITCH



GAMMA'S (FROM MAP)	1	2	3	4	5	6	7	8	9	10
67,000	1	0	1	0	0	0	1	0	0	0
66,500	0	1	1	0	0	0	1	0	0	0
66,000	1	1	1	0	0	0	1	0	0	0
65,500	0	0	0	1	0	0	1	0	0	0
65,000	0	0	0	1	0	0	1	0	0	0
64,500	1	0	0	1	0	0	1	0	0	0
64,000	0	1	0	1	0	0	1	0	0	0
63,500	0	0	1	1	0	0	1	0	0	0
63,000	0	0	1	1	0	0	1	0	0	0
62,500	1	0	0	0	1	0	1	0	0	0
62,000	0	1	0	0	1	0	1	0	0	0
61,500	0	0	1	0	1	0	1	0	0	0
61,000	1	1	0	0	1	0	1	0	0	0
60,500	1	0	1	0	1	0	1	0	0	0
60,000	0	1	1	0	1	0	1	0	0	0
59,500	1	1	1	0	1	0	1	0	0	0
59,000	0	0	0	1	1	0	1	0	0	0
58,500	0	1	0	1	1	0	1	0	0	0
58,000	0	0	1	1	1	0	1	0	0	0
57,500	1	1	0	1	1	0	1	0	0	0
57,000	1	0	0	1	0	1	1	0	0	0
56,500	0	1	0	1	0	1	1	0	0	0
56,000	1	1	0	1	0	1	1	0	0	0
55,500	1	0	1	1	0	1	1	0	0	0
55,000	0	1	0	0	1	1	1	0	0	0
54,500	0	0	1	0	1	1	1	0	0	0
54,000	1	0	1	0	1	1	1	0	0	0
53,500	1	1	1	0	1	1	1	0	0	0
53,000	0	0	0	1	1	1	1	0	0	0
52,500	0	1	0	1	1	1	1	0	0	0
52,000	0	0	0	0	0	0	0	1	0	0
51,500	0	1	1	1	1	1	1	0	0	0
51,000	1	0	0	0	0	0	0	1	0	0
50,500	0	0	1	0	0	0	0	1	0	0
50,000	1	0	1	0	0	0	0	1	0	0
49,500	1	1	1	0	0	0	0	1	0	0
49,000	0	0	0	1	0	0	0	1	0	0
48,500	0	1	0	1	0	0	0	1	0	0
48,000	1	0	1	1	0	0	0	1	0	0
47,500	0	0	1	0	1	0	0	1	0	0
47,000	0	1	1	0	1	0	0	1	0	0
46,500	0	0	0	1	1	0	0	1	0	0
46,000	0	1	0	1	1	0	0	1	0	0
45,500	0	0	0	1	0	1	0	1	0	0

10 POSITION TUNING SWITCH



GAMMA'S (FROM MAP)	1	2	3	4	5	6	7	8	9	10
45,000	0	0	1	1	0	1	0	1	0	0
44,500	0	1	1	1	0	1	0	1	0	0
44,000	0	0	1	0	1	1	0	1	0	0
43,500	0	1	1	0	1	1	0	1	0	0
43,000	1	0	0	1	1	1	0	1	0	0
42,500	1	0	1	1	1	1	0	1	0	0
42,000	1	1	1	1	1	1	0	1	0	0
41,500	0	1	0	1	0	0	1	1	0	0
41,000	0	0	0	1	0	0	0	0	1	0
40,500	0	0	1	1	0	0	0	0	1	0
40,000	0	0	1	0	1	0	0	0	1	0
39,500	0	0	0	1	1	0	0	0	1	0
39,000	0	0	1	1	1	0	0	0	1	0
38,500	0	0	0	1	1	0	0	1	0	0
38,000	0	0	1	0	1	1	0	0	1	0
37,500	0	0	0	1	1	1	0	0	1	0
37,000	0	0	1	0	0	0	1	0	1	0
36,500	0	0	0	1	0	0	1	0	1	0
36,000	0	0	1	1	0	0	1	0	1	0
35,500	0	0	0	1	1	0	1	0	1	0
35,000	0	0	1	1	1	0	1	0	1	0
34,500	0	0	0	0	1	1	1	0	1	0
34,000	0	1	1	0	1	1	1	0	1	0
33,500	0	0	0	0	0	0	0	1	1	0
33,000	0	1	0	0	0	0	0	1	1	0
32,500	0	0	0	0	1	0	0	1	1	0
32,000	0	0	1	1	0	0	1	1	0	0
31,500	0	0	0	1	0	1	0	1	1	0
31,000	1	0	1	0	1	1	0	1	1	0
30,500	0	0	1	1	1	1	0	1	1	0
30,000	0	0	0	0	1	0	1	1	1	0
29,500	0	0	1	1	1	0	1	1	1	0
29,000	0	0	1	0	1	1	1	1	1	0
28,500	0	0	1	0	0	0	1	0	1	1
28,000	0	0	0	1	0	0	1	0	1	1
27,500	0	0	1	0	0	1	1	0	1	1
27,000	0	0	1	0	1	1	1	0	1	1
26,500	0	0	1	0	0	0	0	1	1	1
26,000	0	0	0	0	0	1	0	1	1	1
25,500	0	0	0	0	1	1	0	1	1	1
25,000	0	0	0	1	0	0	1	1	1	1
24,500	0	0	0	1	0	1	1	1	1	1
24,000	0	0	0	1	1	1	1	1	1	1

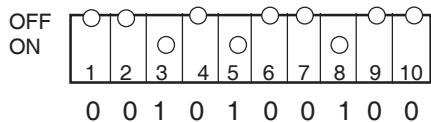
NOT AVAILABLE

OFF=0
ON=1

TUNING EXAMPLE FOR MIAMI FLORIDA

GAMMAS FOR MIAMI, FL
(SEE MAP) = 47,500 gammas

TUNING SWITCH SETUP FOR MIAMI, FL



FISH PREAMP BOARD



FIELD USE

READOUT INTERPRETATION: The key to successful magging is interpretation of the READOUT. If you follow the recommendations below, you will become an expert at it very quickly.

1. Practice on land - have a friend walk (slowly) by the Head carrying different size metal objects and at different distances from the Head. Observe the READOUT while watching him. Keep in mind that the READOUT can only change at the end of READ time (readout will go blank during 1/4 second READ time. Try approaching the Head from different angles. Recommended metal objects: five gallon can, wheelbarrow, car (drive it past Fish).

OBSERVATIONS: (as you are walking past head with metal).

Small object up close - Large change in READOUT but only lasts for one or two cycles.

Small object at distance - Small change in READOUT that lasts for one or two cycles.

Large object up close - Large change in READOUT that lasts for many cycles.

Large object at distance - Small change in READOUT that lasts for many cycles.

2. READOUT will normally change (up or down) while towing - When you are towing the FISH, the READOUT will gradually change as you are making a run (the earths magnetic field is different every 20' or so). This is especially true when magging just off-shore. What you look for is a deviation of the pattern.

DEVIATION EXAMPLE

We were magging for a large object (1/2 of a tanker) and making 1/2 mile runs approximately 200' apart. At the east end of the run, the READOUT was 57,768; at the west end, 57,624. Each run was about the same with the READOUT gradually changing (one pulse difference at a time) during the run. On our eighth run, the count was stepping down as normal when suddenly it dropped - 20, then -60 more, followed by -200 more. As we continued our run, the READOUT jumped back up +150, +125, and by the end of the run was back to normal. Many passes were made, looking for the maximum change (from 57,768) before we dove on the wreck.

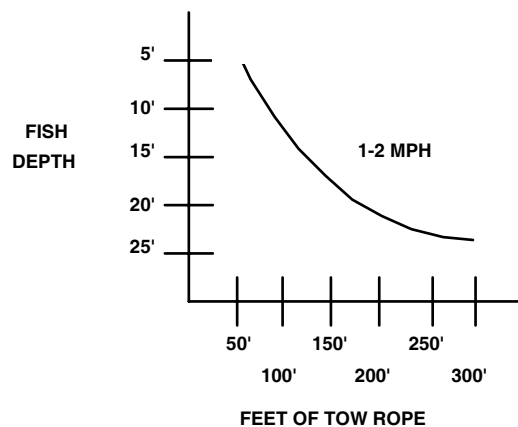
3. Verify reading - Never dive as a result of a single reading. Periodically, you may receive a false reading due to a noise or a malfunction of the mag. Always make several passes to verify.

4. Use buoys - For laying out a grid pattern for searching and for marking readings. When you get a reading, drop a buoy immediately and a second one about 50' later. This gives you alignment for finding the exact spot should you have problems on the next pass. The buoys are a must if you are looking for a small object (cannon).

TOWING: Uncoil the rope on deck and lower the Fish overboard, towing 1-2 MPH. Slowly let out rope the desired amount and tie off. **DO NOT MAKE SHARP BENDS IN THE ROPE.** Do not tie rope off on cleat. Do not coil rope next to motor, or to allow the rope to pass next to the motor; the motor generates a lot of electrical noise, which can be picked up by the cable and cause the readout to be unstable. At the end of a run, do not make a sharp turn, but rather a medium turn at increased speed to prevent Fish from sinking to the bottom. At 2 MPH and 150' of tow rope out, the Fish will be approximately 20' deep.

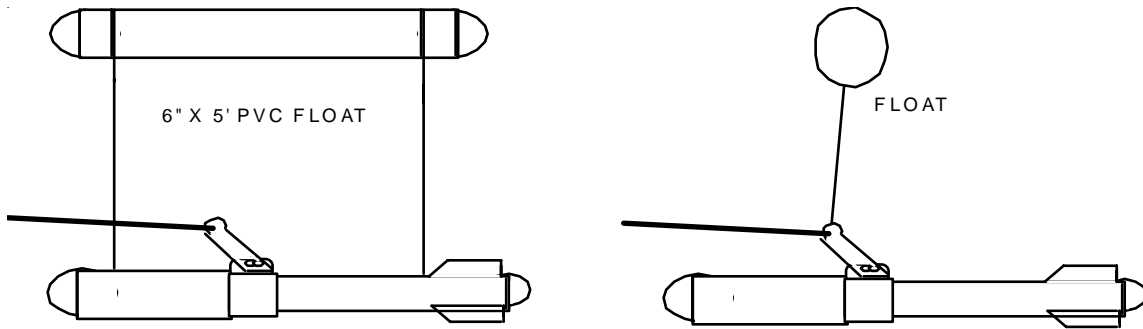
To retrieve the Fish while towing, slow boat to 1-2 MPH and pull in the Fish. If possible, allow tow cable several hours on deck (to drain water) before putting it back in the box. Be sure cable connector is protected from the water at all times (put in plastic bag).

If you are using the UA2 altimeter, be sure the sync cable from the Proton 4 control box is connected to the back of the UA2. If the UA2 is allowed to free-run it will interfere with the Proton 4 readout (readout jumps around).

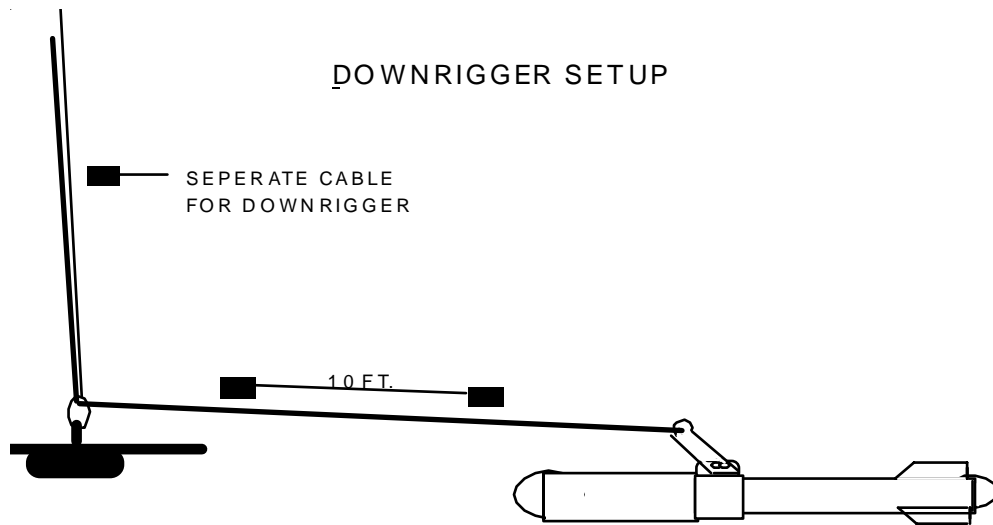


SHALLOW WATER TOWING: In shallow water towing, our goal is keeping the Fish off the bottom. This can be done quite easily by suspending the Fish from a float. The length of the line between the float and the Fish determines Fish depth.

The float can be constructed of a five foot piece of six inch PVC tubing with a cap glued on each end. The ropes are tied off on each end of the Fish. A single ball float can also be used.

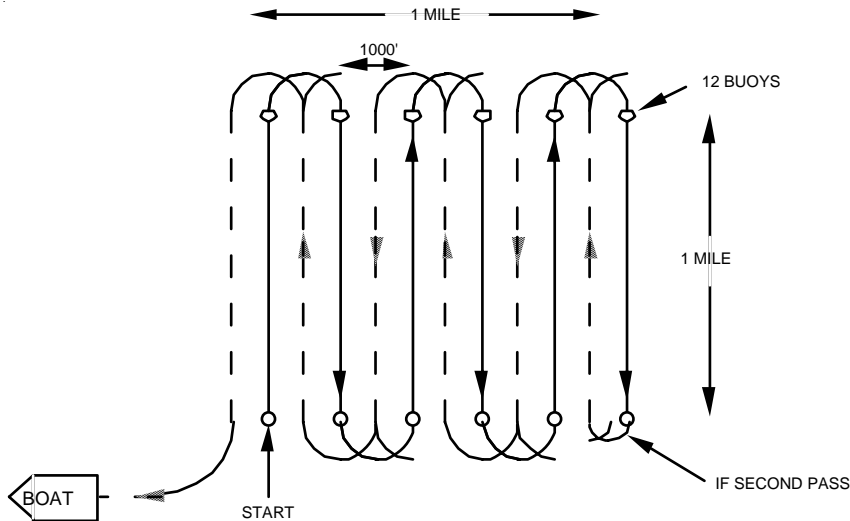


DEEP WATER TOWING: If towing 25-200' deep, then a downrigger must be used. Suspend the depressor wing from a separate cable and tie the Fish 10-15' back from the wing. This setup gives excellent depth control. When used with an Altimeter (our UA-2) very precise control is attainable.



SEARCH PATTERN

In most cases, the quickest and most efficient way to locate the wreck is to do your homework before going out. Once you have pinned the location down (as best you can) on a map, divide the area on the map into square blocks approximately one mile on each side (if a small amount of ferrous metal is involved, a few cannons, reduce the sides to 1/4 mile or less).

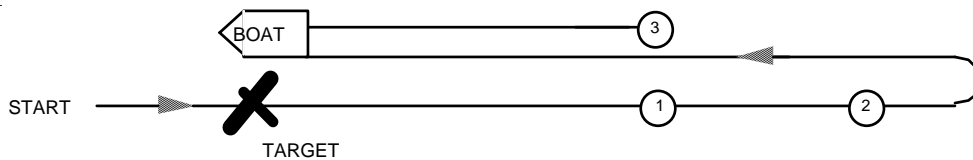


Head out to the site with approximately twenty buoys (not all the same color) and lay the buoys out 1000' apart (for ship size object) on two opposite sides of one of the search areas. Make your run (magg) from one buoy to another until you have completely covered the block. To double check, make a second pass, this time between buoys. After finishing the second pass, pull in the mag and pick up all buoys except the four outside buoys (left for reference). Lay out the buoys for an adjoining block and repeat the sequence.

PINPOINTING THE WRECK

Despite its sensitivity, pinpointing a wreck is quite simple.

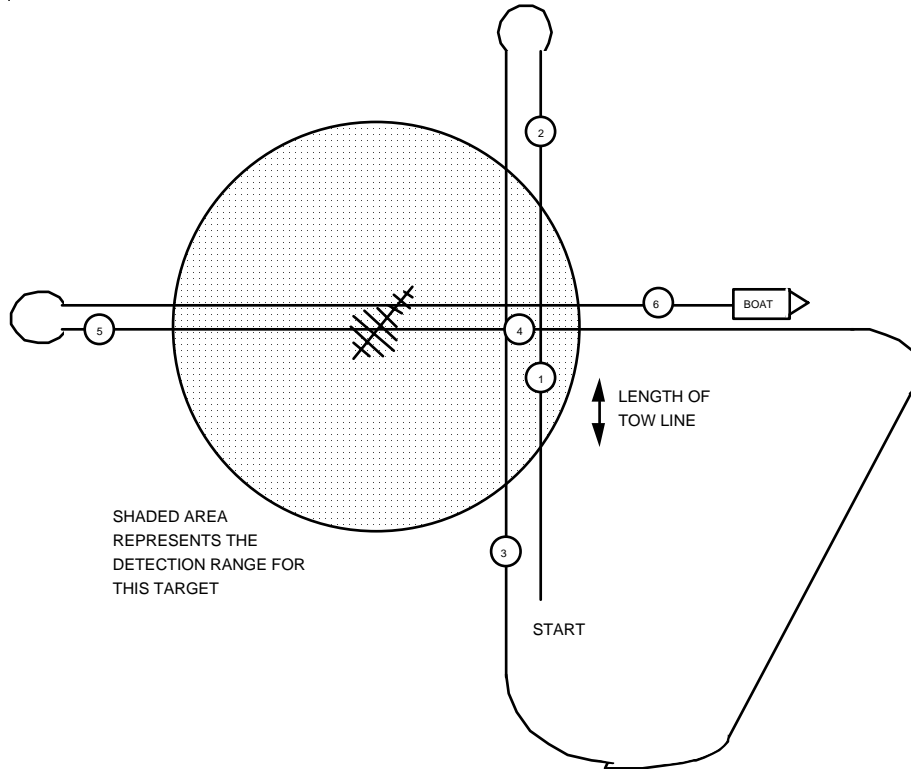
SMALL OBJECTS: (small or large change that lasts for one or two cycles). If you get a reading indicating a small metal mass, drop the first buoy when the readout indicates a maximum change followed by a second buoy 50' later (the second buoy gives you a straight line to work from). Swing the boat around (pull in the Fish and drag a third buoy from the boat whose line length is the same tow line for the Fish).



Line the boat up with the two buoys (#1 and #2) and make a pass in the opposite direction. When buoy #3 is next to buoy #1, drop anchor (boat is over target).

NOTE: Always verify finding by making several passes with the mag before diving.

LARGE OBJECTS: (small and large changes that last for many cycles). Drop buoy #1 (for a straight line reference) as soon as you start getting readings. Continue at same heading; when you lose target on mag, drop buoy #2. Swing boat around and make another pass in the opposite direction. You should pick up the target once again. When you lose it, drop buoy #3.



NOTE: At this point, you know that the target lies in the center area between buoys #2 and #3, but you do not know if the target is to the left or to the right. The next series of passes will pinpoint the target.

After dropping buoy #3, swing the boat around so that you will be making a run that is perpendicular to the first two runs and cuts through the center area of buoys #2 and #3 (this run should produce very large changes in the readout). When the mag picks up the target, drop buoy #4 (for a straight line reference) and continue on course. When you lose the target, drop buoy #5. Swing the boat around and make a pass in the opposite direction. Once again, you should pick up the target; when you lose the target, drop buoy #6.

Pull in the mag and drop anchor between buoys #5 and #6.

PROCEDURES

The following is a list of procedures that may be required for operation, adjustments, or maintenance:

<u>PROCEDURE</u>	<u>DESCRIPTION</u>
P1	Filling sensor housing with charcoal lighter fluid.
P1.1	Nose cone removal.
P2	Loran C and GPS cabling.
P3	System checkout - From inside of a building.
P4	Fish tail section removal.
P5	Fish preamp access for tuning.
P6	Map instructions.
P7	12 v battery hookup.
P8	Tow line replacement.
P9	Cable wiring
P10	Fish Pre-Amp replacement.
P11	RS232 cabling.

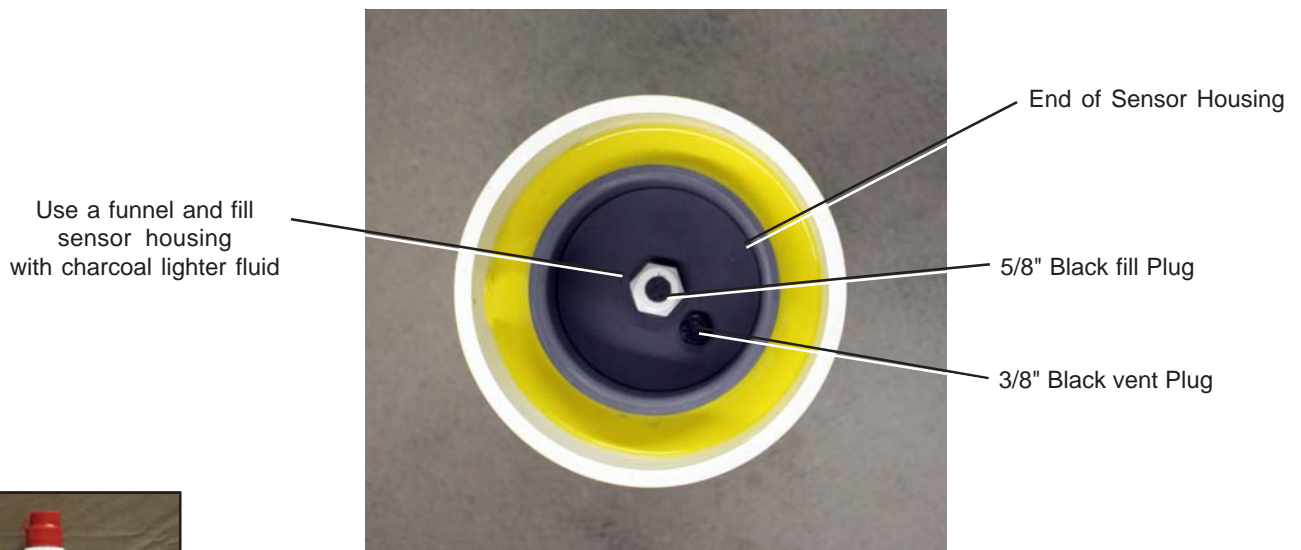
P1 FILLING SENSOR HOUSING WITH FLUID

Do not operate the magnetometer until the sensor housing has been filled with charcoal lighter fluid or lighter fluid. The unit was shipped without fluid, which must be purchased locally (approximately 1 1/2 quarts of fluid = 1.4 L). If the fluid is in a metal can (plastic container is ideal) then use a coffee filter to filter any possible bits of metal out of the fluid before pouring it in the sensor housing.

The following procedure is best performed by two people:

1. Remove the fish nose cone (see P1.1 next page).
2. Stand the unit upright with the tail cone resting on the floor.
3. Using a 15/16" wrench, remove the center 5/8" aluminum plug (do not lose the o-ring under the head of the bolt).
4. Using a 9/16" wrench, remove the 3/8" black aluminum vent plug (do not lose the o-ring under the head of the bolt).
5. Wear safety glasses.
6. Using a small funnel slowly pour the charcoal lighter fluid into the 5/8" center hole. Continue filling until the liquid comes out of the vent hole. The sensor chamber will hold about 1 1/2 quarts (1.4 L).
7. When the chamber is full, insert the plugs back into the holes finger tight. Shake the mag slightly to get any trapped air to the top of the chamber (you can hear the fluid sloshing around indicating there is air trapped inside.) Remove the plugs and refill.
8. When the chamber is full, insert the vent and fill plugs into the holes. **Careful not to cross-thread (will damage the threads). Do not over tighten**, just snug will do (once o-ring makes contact, a 1/4 turn will seal the housing. Use a paper towel to clean up any left over fluid around the bolt heads.
9. Reinstall the fish nose cone (see P1.1 next page).

Proton 4 - Nose End View



Charcoal Lighter Fluid.....or.....Lighter Fluid

P1.1 NOSE CONE REMOVAL

The nose cone is constructed of solid black epoxy.

1. Remove the three screws holding the cone in place-they should not be tight.
2. Observe the filed notch in the cone next to the top screw. When reinstalling, this notch must line up to the top hole or the other holes will not line up.
3. Insert a large/long screwdriver into the vent hole next to the cone and push/pry the cone out (it is snug fit).

P2 LORAN C and GPS CABLING

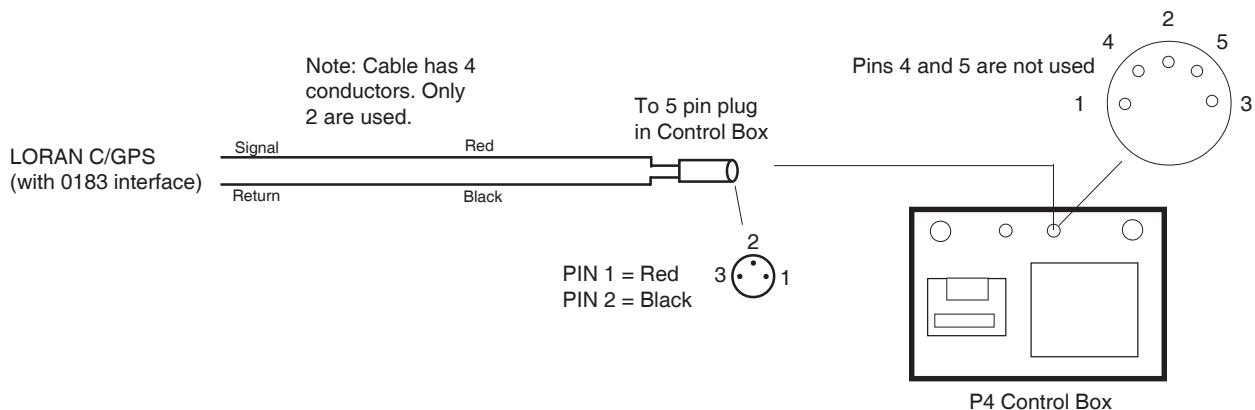
The Proton 4 accepts standard NMEA 0183 serial data (NOT USB) information obtained from a connected GPS or Loran C receiver to display your boat's heading and position (Latitude and Longitude). For most GPS systems you will need to enable the data output, select a version of NMEA 0183 to output and select the output's baud rate (data speed). These selections are usually made through your receiver's Setup menu. Please refer to your GPS or Loran C users manual for detailed instruction.

Baud rate – The Proton 4 uses the industry standard speed of 4800 baud for the NMEA 0183 interface. If your receiver offers a selection of alternate baud rates, select 4800.

The Proton 4 accepts only GLL or GGA position information sentences and is limited to a maximum of 6 decimal place precision. The information sent from the GPS or LORAN must include either the GLL or GGA sentence with no more than 6 decimal place precision.

The GPS or LORAN connects to a 5 pin DIN connector on the the Proton 4 control panel. Two interface cables are supplied.

Interface Cable #1: A modified three pin DIN connector on one end, and bare wires on the other. This cable connects to the Proton 4 as follows
(Note: The wire has (4) conductors, only the red and black wires are used):



Interface Cable #2: (GPS ADAPTOR) A modified three pin DIN connector on one end, and a 9 pin D connector on the other. Many GPS Systems are supplied with a 9 pin D serial data output cable. Use Interface Cable #2 to adapt the 9 pin D serial data cable to connect to the 5 pin DIN connector on the Proton 4 control panel.

NOTE: The GPS must be cabled to the Proton 4, operating and a position fix must be obtained before turning on the Proton 3/4 power switch. The Proton 4 checks for a GPS on power up only. If the GPS is not turned on when the Proton 4 is turned on, the Proton 4 will never see it.

P3 SYSTEM CHECKOUT - FROM INSIDE OF A BUILDING

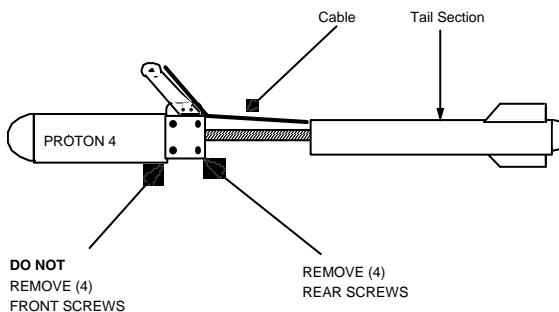
The system will not work properly from inside of a building (readout will jump around), but the system can be checked to be sure it is cycling properly. Cable up the unit and apply 24 vdc. When you turn the unit on, it should operate as stated in the manual except the readout will not give a steady reading regardless of how you tune it, and it will not detect metal. This is a good checkout to insure the system is cycling ok. If you unplug the cable from the fish the system, the alarm should sound and the readout will remain blank. This indicates that incorrect information was received from the fish. The system will continue to cycle, and will repeat the above. If you plug in the cable, the alarm will go off and the display will show the latest reading once again.

After making a preliminary check in the building, final checkout and tuning (if needed) must be made in a field well outside of the city and away from all metal.

P4 TAIL SECTION REMOVAL

REMOVAL

1. Position the fish on a flat surface.

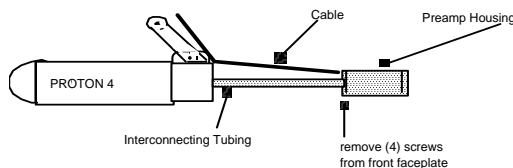


2. Remove the four rear screws from the tow collar that hold the tail section in place (note that the hole and slot are on the top side of the tail section).
3. Pull straight back on the tail section of the fish while holding the head section in place (be careful that the cable does not get caught on the tail section).
4. Support the preamp housing.

P5 FISH PREAMP ACCESS FOR TUNING SWITCH

REMOVAL

1. Remove the tail section of the fish (see P4 above). Support the preamp housing..



2. Remove the four screws from the front faceplate.
3. Slide the preamp housing off (do not lose the o-ring).
4. Adjust the tuning switch as per instructions in the operation section of this manual.

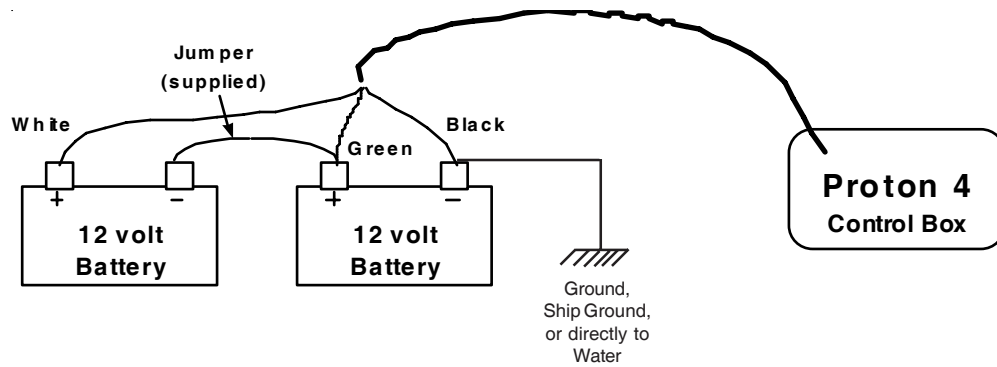
P6 MAP INSTRUCTIONS

The purpose of the world map is to inform you of the normal gamma reading in your area. This information is necessary for tuning the Fish so it will operate in your area. The map shows the strength of the earth's magnetic field in your area listed in gammas (purple lines). These are the numbers you can expect to be displayed in the readout when operating the mag in the G1 position. If your immediate area is located between the purple lines, then your frequency will be less or more than the number on the line. The map gamma numbers are approximate, however the actual readout should be in the area.

Once you have established what the gamma reading should be in your area the fish is tuned by turning on or off each of the 10 switches on the pre amp board. The red dot on the "rocker arm" dip switch is depressed down to turn on (1) the switch position. See the operation section of this manual for switch tuning positions.

P7 24 VOLT BATTERY HOOKUP

The Proton 4 requires 24 vdc to power the system. This is accomplished by wiring two 12 volt car or marine batteries in series (see below). Caution: Failure to properly connect batteries could damage the Proton 4 control box, batteries, and power cable. It is recommended that the boat battery not be used. The engine electrical noise could cause the Proton 4 readout to be unstable.



Note: grounding the -12 volts helps to reduce noise which gives a steadier readout.

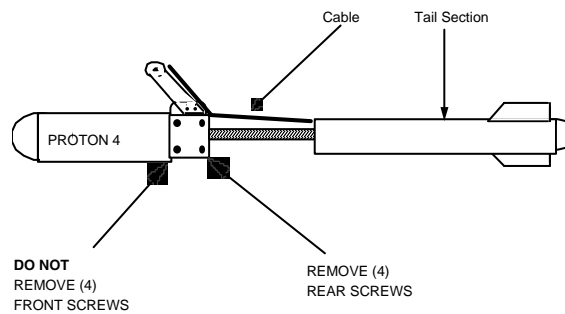
P8 TOW LINE REPLACEMENT

The tow line for the Proton 4 consists of a coax and multi-paired cable which is fed through a hollow core polypropylene rope.

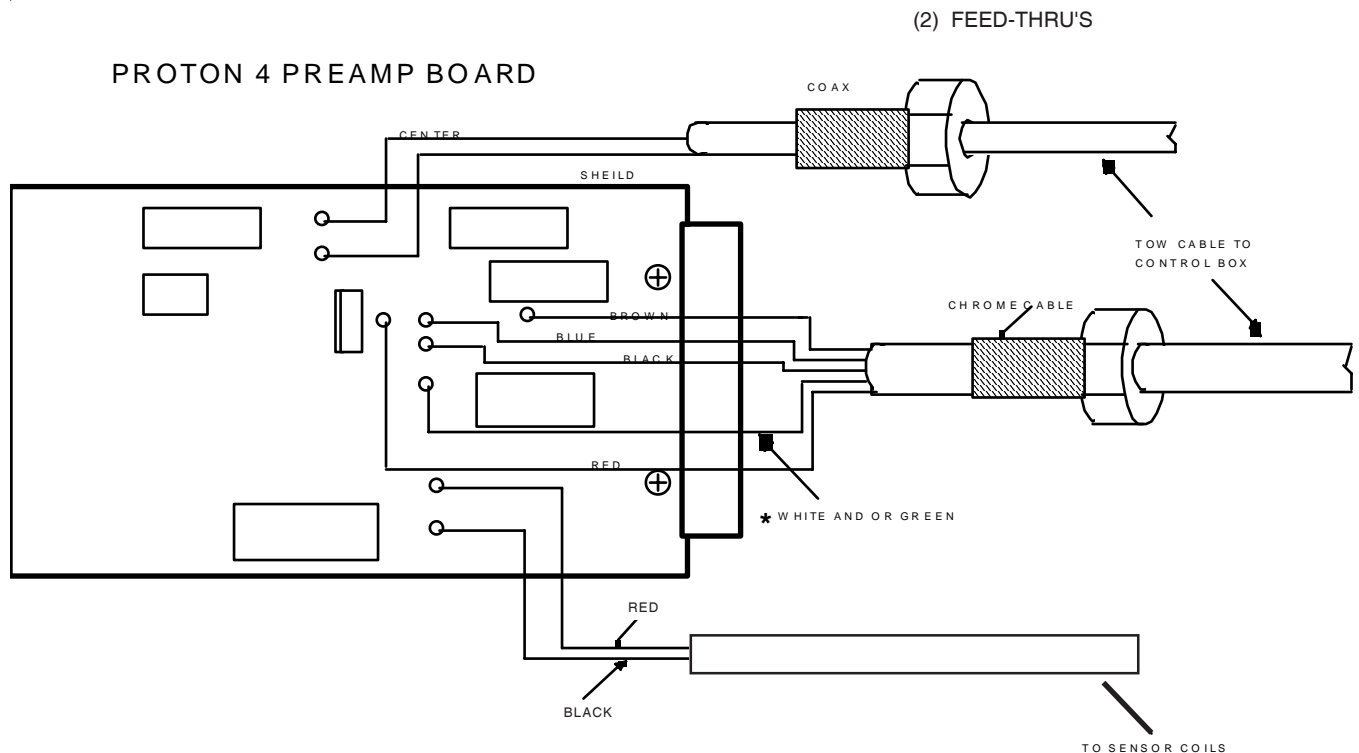
NOTE: The rope at some point may have lumps or open areas. This is caused by manufacturing splices of individual strands within the rope.

REMOVAL

1. Position the fish on a flat surface.



2. Remove the four rear screws from the tow collar (note that the hole and slot are on the top side of the tail section).
3. Pull back on the tail section of the fish. Refer to P4.
4. Remove the preamp housing. Refer to P5.



* Depending on cable length

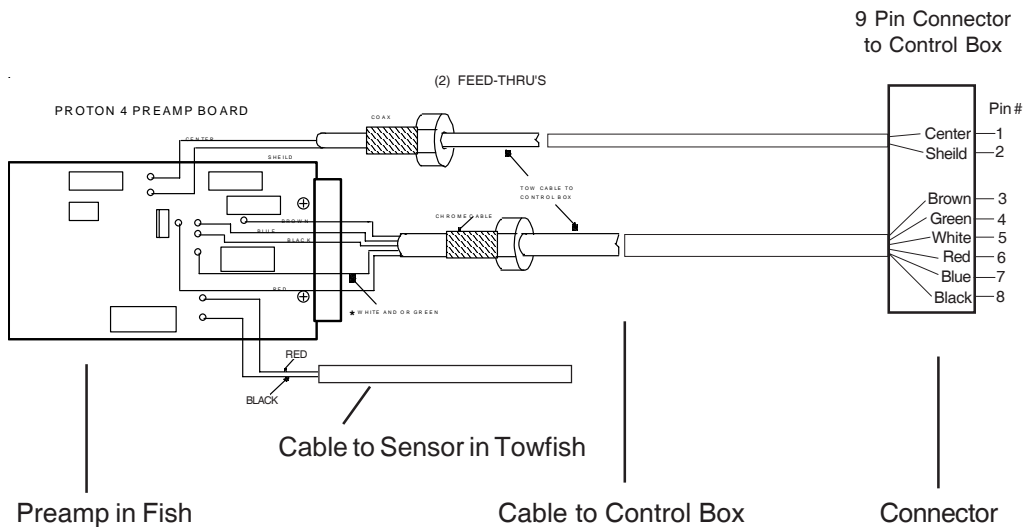
4. Unsolder wires from board.
5. While holding the head of the feed-through connectors with your fingers, loosen the nuts (with a wrench) from the faceplate.

REPLACEMENT

1. Install new cables by reversing above procedures.

NOTE: Be sure o-rings are in place on the feed-through connectors and on the case (large o-ring). Be sure your wiring is correct before closing up.

P9 CABLE WIRING



Pin 1. Coax center. This wire carries the return signal from the preamp board in the towfish.

Pin 2. Coax shield. This wire carries the return signal ground.

Pin 3. Brown wire is the Pol signal.

Pin 4. Green wire is for is for the head current during Pol time (current must be 1.5 amps).

Pin 5. White wire is not used.

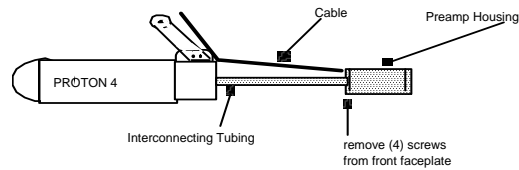
Pin 6. Red wire is +12 vdc.

Pins 7 & 8. Blue and Black wires are ground.

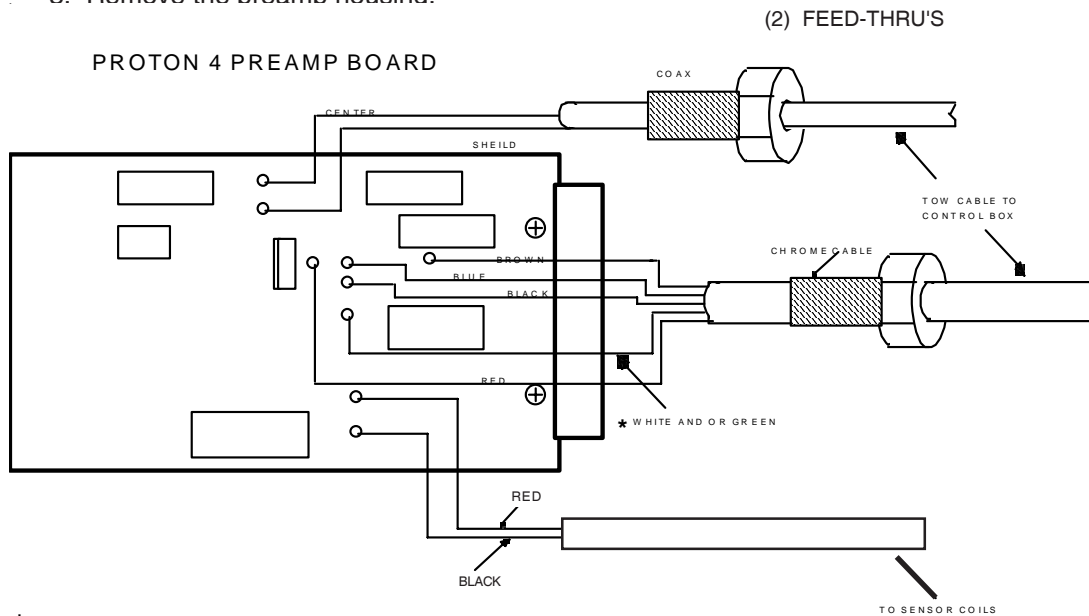
P10 PRE-AMP BOARD REPLACEMENT

Should it be necessary to replace the Pre-Amp board, perform these steps below.

1. Remove the tail section from the fish (see P4).



2. Remove the four screws from the front faceplate of the preamp housing. See P5.
3. Remove the preamp housing.



* Depending on cable length

5. Unsolder wires going to the feed-thru fittings.
6. Remove two screws holding Pre-Amp to mounting plate.
7. Install new board.

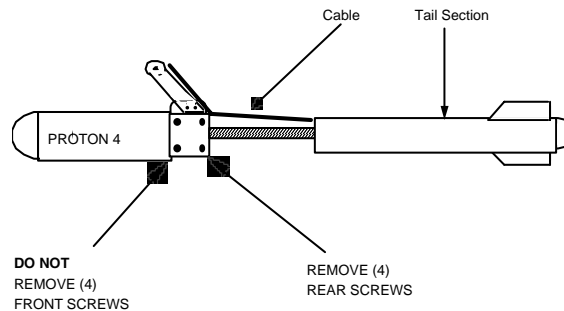
REASSEMBLY

1. Reverse above procedure.

NOTE: Be sure to clean o-ring and seat. The o-ring should be lubricated with silicon grease before installing.

PROTON 4 PRESSURE TEST PROCEDURE

1. Remove the tail section. See diagram.
 - a. Position the fish on a flat surface.
 - b. Remove the four rear screws from the tow collar that hold the tail section in place (note that the hole and slot are on the top side of the tail section).
 - c. Pull straight back on the tail section of the fish while holding the head section in place (be careful that the cable does not get caught on the tail section).
 - d. Support the preamp housing.



2. Remove the black plug from rear faceplate in the preamp housing.
3. Get pressure test plug from spare parts kit included with magnetometer. Below is a photo of the pressure test plug. Make sure there is an O-ring under the head of the plug.
4. Screw in the pressure plug in place of the plug removed in Step 2. Snug down the plug but do not over tighten.
5. Attach a bicycle pump to the pressure fitting. Pump about 10 to 15 pounds of air into housing.
CAUTION: DO NOT EXCEED 15 LBS.
6. Place fish in water. A few bubbles will come out initially from under the collar that the fins are attached to.
10. Keep the fish in the water for a few minutes and watch for a steady stream of bubbles from around the rear flange, faceplate, or where the wires enter the housing. If there are no bubbles escaping from anywhere on the fish, the housing is watertight.
11. Remove the pressure plug and reinstall the black plug that was removed in Step 2.
12. Reattach tail section.



Pressure Test Plug

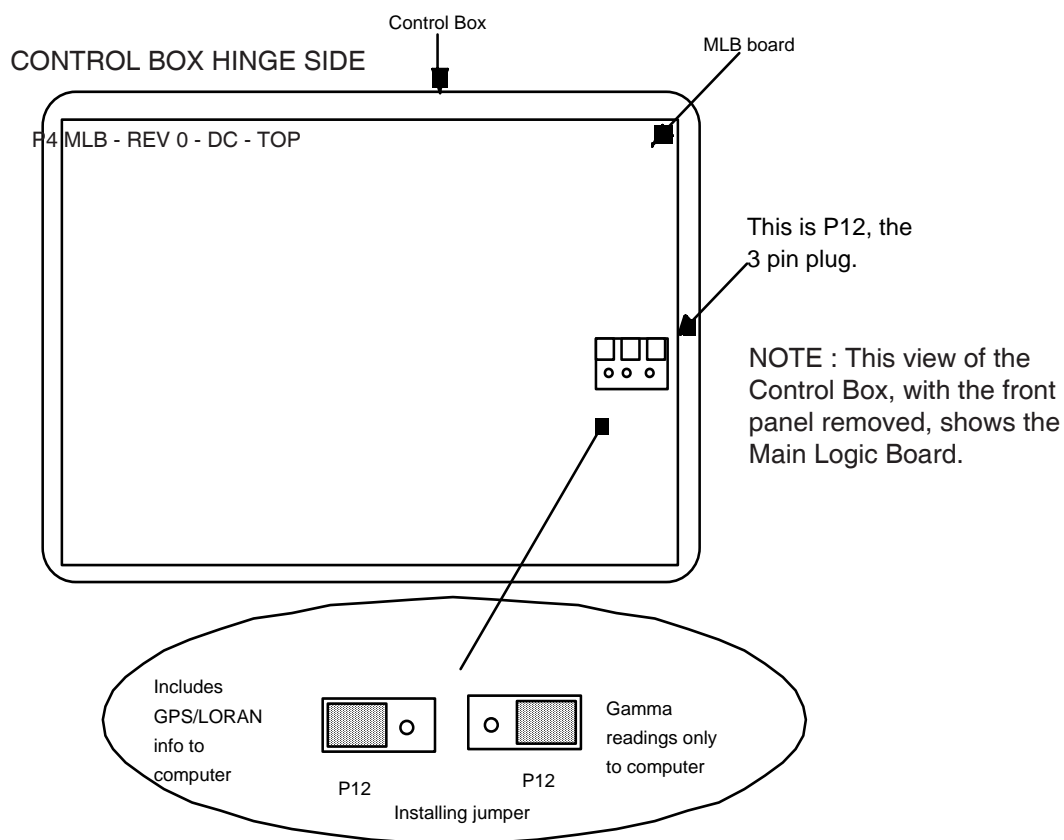
P11 RS232 COMPUTER INTERFACE CABLING

The Proton 4 can be connected to any computer or data recorder equipped with an RS232 input. The specification for the interface is as follows:

- 8 bit ASCII
- 4800 baud rate
- 1 stop bit
- no parity bit.

The operator can choose whether or not to include the LORAN C/GPS coordinates in the data by changing the position of shorting plug P12 on the MLB circuit board in the control box. To access the MLB:

1. Remove the (4) four screws on the edges of the control panel.
2. Lift the panel to expose the circuit boards.
3. See the diagram for the location of P12:



4. Use the shorting plug to connect the left pin and the center pin to include LORAN C/GPS and gamma readings. Use the shorting plug to connect the right pin and the center pin to include gamma readings only. If your Proton 4 was purchased with the Loran C/GPS interface, the P12 jumper was factory installed in the left hand position. If you do not have your Loran/GPS receiver hooked up, false position information will be transmitted on the RS232 interface. If this causes a problem with your computer program, install the P12 jumper to the right position which insures that the false position information will not be sent.

5. Reinstall the control panel and screws.

The sample data message sent on the RS232 interface is as follows:

with plug P12 in the right-hand position:

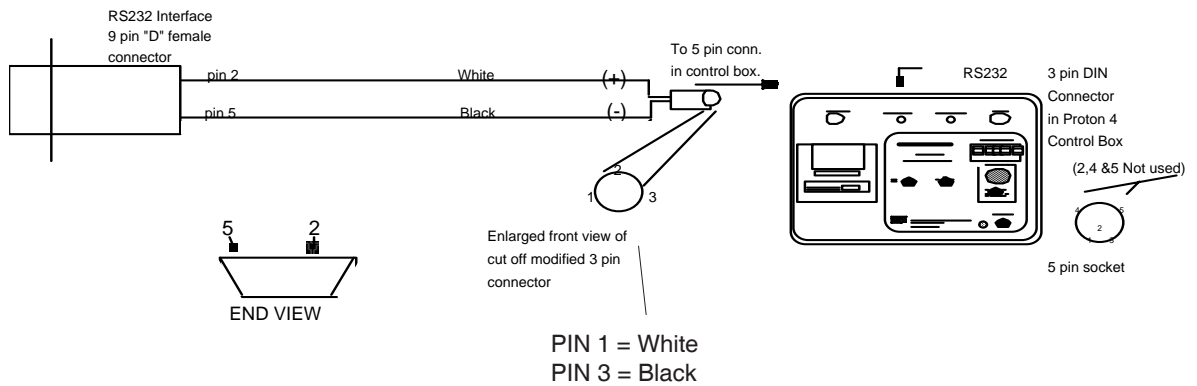
@46308 4149.5645,N,07102.7125,W<OD><OA>
Gamma reading (space) LORAN C/GPS coordinate, carriage return, line feed

with plug P12 in the left-hand position or without a LORAN C or GPS connected:

@46308 <OD><OA>
Gamma reading, carriage return, line feed

The message repeats once for each cycle of the magnetometer.

The RS232 interface uses two wires and is wired to the modified three pin DIN connector (CENTER PIN CUTOFF) on the PROTON 4 as follows:



TROUBLESHOOTING

PROBLEM #1

Readout is blank and alarm "beeps" - This indicates that incorrect or no information is coming from the fish.

Possible causes:

- 1) Broken cable.
- 2) Damaged cable connector (where fish cable plugs into control box).
- 3) Bad preamp in fish.

PROBLEM #2

Proton 4 stops cycling - One or both 12 volt batteries need recharged.

CALL FACTORY IF ANY PROBLEMS

800-822-4744 ph

508-822-7330 ph

508-880-8949 fax

jwfishers@aol.com email

LIMITED WARRANTY

The Warranty on the Proton 4 is for two years from date of purchase and is limited to the electronic portion of the unit. The Warranty does not include broken or damaged tow line or lost equipment. Should service be required, contact us explaining the nature of the problem. Most problems can be isolated over the phone and correct replacement parts sent to you. In some cases, we may have you return an assembly for checkout. In almost all cases, the Proton 4 is field repairable.