

Operation Manual

G-882

Cesium Magnetometer

p/n 770-00031-01 Rev. H
(FS p/n 25919-OM)

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GEOMETRICS

Simplify your search

2190 Fortune Drive, San Jose, CA 95131 USA
Tel: (408) 954-0522 • Fax: (408) 954-0902 • geometrics.com

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March 14, 2003
Sunnyvale, California, USA

EC DECLARATION OF CONFORMITY

We, Geometrics, Inc.
Geometrics Europe
2190 Fortune Drive
San Jose, CA 95131 USA
ph: (408) 734-4616
FAX: (408) 745-6131

declare under our sole responsibility that our marine magnetometers, models G-880, G-881 and G-882 to which this declaration relates are in conformity with the following standards:

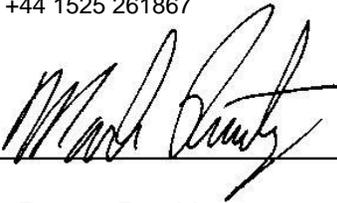
EN 55022: 1995, EN50082-2 : 1995, ENV 50140: 1994, ENV 50141 : 1994, EN 61000-4-2: 1995, EN 61000-4-4: 1995

per the provisions of the **Electromagnetic Compatibility Directive 89/336/EEC** of May 1989 as Amended by *92/31/EEC* of 28 April 1992 and *93/68-EEC, Article 5* of 22 July 1993.

The Technical documentation required by Annex IV(3) of the Low Voltage Directive is maintained by Christopher Leech of Geometrics Europe (address below).

The authorized representative located within the Community is:

Geometrics Europe
Christopher Leech
Manor Farm Cottage
Galley Lane
Great Brickhill
Bucks.MK17 9AB, U.K.
ph: +44 1525 261874
FAX: +44 1525 261867



Mark Prouty, President
San Jose, CA, USA

Warning

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

G-882 MARINE MAGNETOMETER

- *CESIUM VAPOR HIGH PERFORMANCE – Highest detection range and probability of detecting all sized ferrous targets*
- *NEW STREAMLINED DESIGN FOR TOW SAFETY – Low probability of fouling in fishing lines or rocks*
- *NEW QUICK CONVERSION FROM NOSE TOW TO CG TOW – Simply remove an aluminum locking pin, move tow point and reinsert. Now with built in easy carry handle!*
- *NEW INTERNAL HIGH PERFORMANCE CM-221 COUNTER MODULE – UP TO 40 HZ – Provides Flash Memory for storage of default parameters set by user*
- *NEW ECHOSOUNDER / ALTIMETER OPTION*
- *DEPTH RATING – 4,000 psi (2,700M)!*
- *HIGHEST SENSITIVITY IN THE INDUSTRY – 0.004 nT/√Hz RMS with the internal CM-221 Mini-Counter*
- *EASY PORTABILITY & HANDLING – no winch required, single man operation, only 44 lbs. with 200 ft. cable (without weights)*
- *COMBINE TWO SYSTEMS FOR INCREASED COVERAGE – Internal CM-221 Mini-Counter provides multi-sensor sync and data concatenation allowing side by side coverage which maximizes detection of small targets and reduces noise*

Very high resolution Cesium Vapor performance is now available in a low cost, small size system for professional surveys in shallow or deep water. High sensitivity and sample rates are maintained for all applications. The well proven Cesium sensor is combined with a unique and new CM-221 Larmor counter and ruggedly packaged for small or large boat operation. Use your computer and standard printer with our MagLog Lite™ software to log, display and print GPS position and magnetic field data. The G-882 is the lowest priced, high performance, full range marine magnetometer system ever offered.



**G-882 with Weight Collar
Depth Option & Altimeter**

The G-882 offers flexibility for operation from small boat, shallow water surveys as well as deep tow applications (4,000 psi rating, telemetry over steel coax available to 10 km). The G-882 also directly interfaces to all major Side Scan manufacturers for tandem tow configurations. Being small and lightweight (44 lbs. net, without weights) it is easily deployed and operated by one person. But add several streamlined weight collars and the system can quickly weigh more than 100 lbs. for deep tow applications. Power may be supplied from a 24 to 30 VDC battery power or the included 110/220 VAC power supply. The tow cable employs high strength Kevlar strain member with a standard length of 200 ft. (61 m).

The maximum useable cable length with the standard power supply is 300 m; 800 m with a Mini-Xantrex voltage

sense power supply; and up to 6000 m with telemetry over coax. A rugged fiber-wound fiberglass housing is designed for operation in all parts of the world allowing sensor rotation for work in equatorial regions. The shipboard end of the tow cable is attached to an included junction box or optional on-board cable for quick and simple hookup to power and output of data into any Windows 98, ME, NT, 2000 or XP computer equipped with RS-232 serial ports.

The G-882 system is particularly well suited for the detection and mapping of all sizes of ferrous objects. This includes anchors, chains, cables, pipelines, ballast stone and other scattered shipwreck debris, munitions of all sizes (UXO), aircraft, engines and any other object with magnetic expression. Objects as small as a 5 inch screwdriver are readily detected provided that the sensor is close to the seafloor and within practical detection range. (Refer to table at right).

The design of this high sensitivity G-882 marine unit is directed toward the largest number of user needs. It is intended to meet all marine requirements such as shallow survey, deep tow through long cables, integration with Side Scan Sonar systems and monitoring of fish depth and altitude.

Typical Detection Range For Common Objects

1.	Ship 1000 tons	0.5 to 1 nT at 800 ft (244 m)
2.	Anchor 20 tons	0.8 to 1.25 nT at 400 ft (120 m)
3.	Automobile	1 to 2 nT at 100 ft (30 m)
4.	Light Aircraft	0.5 to 2 nT at 40 ft (12 m)
5.	Pipeline (12 inch)	1 to 2 nT at 200 ft (60 m)
6.	Pipeline (6 inch)	1 to 2 nT at 100 ft (30 m)
7.	100 KG of iron	1 to 2 nT at 50 ft (15 m)
8.	100 lbs of iron	0.5 to 1 nT at 30 ft (9 m)
9.	10 lbs of iron	0.5 to 1 nT at 20 ft (6 m)
10.	1 lb of iron	0.5 to 1 nT at 10 ft (3 m)
11.	Screwdriver 5 inch	0.5 to 2 nT at 12 ft (4 m)
12.	1000 lb bomb	1 to 5 nT at 100 ft (30 m)
13.	500 lb bomb	0.5 to 5 nT at 50 ft (16 m)
14.	Grenade	0.5 to 2 nT at 10 ft (3 m)
15.	20 mm shell	0.5 to 2 nT at 5 ft (1.8 m)

MODEL G-882 CESIUM MARINE MAGNETOMETER SYSTEM SPECIFICATIONS

OPERATING PRINCIPLE:	Self-oscillating split-beam Cesium Vapor (non-radioactive)
OPERATING RANGE:	20,000 to 100,000 nT
OPERATING ZONES:	The earth's field vector should be at an angle greater than 10° from the sensor's equator and greater than 6E away from the sensor's long axis. Automatic hemisphere switching.
CM-221 COUNTER SENSITIVITY:	<0.004 nT/ π Hz rms. Up to 20 samples per second
HEADING ERROR:	< 1 nT (over entire 360° spin)
ABSOLUTE ACCURACY:	<2 nT throughout range
OUTPUT:	RS-232 at 1,200 to 19,200 Baud
MECHANICAL:	
Sensor Fish:	Body 2.75 in. (7 cm) dia., 4.5 ft. (1.37 m) long with fin assembly (11 in. cross width), 40 lbs. (18 kg) Includes Sensor and Electronics and 1 main weight. Additional collar weights are 14lbs (6.4kg) each, total of 5 capable
Tow Cable:	Kevlar Reinforced multiconductor tow cable. Breaking strength 3,600 lbs., 0.48 in OD, 200 ft. maximum. Weighs 17 lbs. (7.7 kg) with terminations.
OPERATING TEMPERATURE:	-30°F to +122°F (-35°C to +50°C)
STORAGE TEMPERATURE:	-48°F to +158°F (-45°C to +70°C)
ALTITUDE:	Up to 30,000 ft. (9,000 m)
WATER TIGHT:	O-Ring sealed for up to 4,000 psi (9000 ft. or 2750 m) depth operation
POWER:	24 to 32 VDC, 0.75 amp at turn-on and 0.5 amp thereafter
ACCESSORIES:	
Standard:	Operation manual, shipping storage container and ship kit with tools and hardware
Optional:	Telemetry to 6Km coax, gradiometer (longitudinal or transverse TVG), aluminum reusable shipping case
MagLog Lite™ Software:	Logs, displays and prints Mag and GPS data at full sample rate. Automatic anomaly detection and single sheet Windows printer support

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

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GEOMETRICS INC. 2190 Fortune Drive, San Jose, California
 95131, USA Tel: 408-954-0522 – Fax: 408-954-0902 – Email:
sales@geometrics.com Web: www.Geometrics.com
GEOMATRIX UK 20 Eden Way, Pages Industrial Park, Leighton Buzzard LU7
 4TZ, UK Tel: 44-1525-383438 – Fax: 44-1525-382200 – Email:
chris@georentals.co.uk sales@georentals.co.uk - Web: www.Geomatrix.co.uk

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1.0 Introduction

The G-882 Marine Magnetometer has been designed and manufactured for simple and reliable use while generating supreme marine magnetic data quality. The purpose of this manual is to give new users start up information and experienced users reference information.

We begin with an introductory overview on to how the system works and then provide a Quick Start Hardware Guide to show you how to connect the magnetometer fish and tow cable system. The G-882 offers field convertible nose tow or CG (center of gravity tow) configurations and we explain how to convert one to the other. In general the nose tow is used in shallower applications, the CG tow for deeper tow requirements.

We continue with a description of the Kellems grip cable attachment system and how it is used to safely attach your tow system to a secure point on your vessel or towing winch. The Quick Start Hardware Guide concludes with a section on connecting the tow cable (or on-board deck cable) to the power-data-junction box, power supply and PC computer for data logging

Most G-882 magnetometers are supplied with our MagLog Pro (NT) or MagLogLite software which runs on a Windows™ PC. A [Quick Start Software Guide](#) walks you through the basic setup using the MagLog Survey Wizard to configure logging of the magnetometer, GPS and printer. We suggest that the user refer to the MagLog manual for more in-depth setup and operational information after using the Quick Start Guide.

Your data may be processed in our accessory software MagMap and MagPick programs, also supplied with the magnetometer. Please review those manuals for processing steps and map making. The manuals are part of the software installation and can be found under the Help tab.

After the Quick Start Guides we offer the main part of the manual where we discuss deployment scenarios, tow depths, sensor orientation requirements, digital data transmission formats, troubleshooting and service information.

We have produced this manual to provide you with a basic understanding of the procedures required to obtain the best survey data obtainable and give you some tips on how to care for your magnetometer system. It is not meant to be exhaustive for every case as there are many different situations and applications in which the magnetometers can be used. As always, we are here to support you and help you get the most out of your system, so we encourage you to call or email us with questions.

Contact information:

Technical support@geometrics.com

Sales sales@geometrics.com

Tel: 408-954-0522

Fax: 408-954-0902

1.1 How it Works

The G-882 magnetometer employs an optically pumped Cesium-vapor atomic resonance system that functions as the frequency control element in an oscillator circuit. The frequency of the magnetometer's electrical oscillator is known as the Larmor frequency. In Appendix A, we give a more complete description of the internal working of the sensor, but here it suffices to say that this oscillation varies with the external ambient magnetic field. We measure those variations and send them to a computer for display and recording.

Where there are materials that have iron in them (like cables, pipelines, different types of rock, small artifacts like nails or big items like a steel ship) the earth's field distorts about the object and the cesium magnetometer sees this distortion as an increase or decrease in earth's field intensity. In the northern hemisphere, we will typically see an "anomaly" over a ferrous object which presents dipole structure with a magnetic high to the south of the object and a magnetic low to the north. This phenomenon is fully described in our Applications Manual for Portable Magnetometers (AMPM) which is available on the Magnetometer CD that comes with the system. It is also available on our website (www.geometrics.com).

The very high sensitivity of the cesium magnetometer allows it to detect small targets at quite large distances. For localized objects, the magnetometer can sense anomalies of 1 ton (1000 kgs) of iron or steel at 100 feet (30m) or more, 250 lbs. (100kgs) at 50 ft. (15m) and 30 lbs. (15kgs) at 25 feet (10m) or more depending on the background magnetic noise level of the earth.

Survey design is crucial to generating a data set that gives you the answers you want. In general the height of the magnetometer above the sea floor must be controlled to enable detection of the survey objective. Survey line spacing should be approximately equal to twice the detection distance to the search object for 100% coverage. The AMPM manual will give additional information on survey design for different applications such geological survey and object location. In addition, we are available to consult with you via phone or email to help you design your survey for maximum productivity.

1.2 Warranty/Voiding of Warranty

The G-882 Magnetometer is warranted for 24 months. Extended warranties may be available; please contact the factory. All goods not of Geometrics manufacture are warranted by the original manufacturer's warranty.

Warranties commence on the date of shipment. Geometrics must be notified within 7 days of failure of the system to initiate a warranty claim. If the equipment fails due to manufacturing defects during the warranty period, Geometrics will repair or replace the defective item at its facility in California at no charge to the customer for parts and labor. The cost to ship the equipment to Geometrics factory in San Jose, California and back to the customer's site is for the customer's account.

Repairs might be done at a local service center if available, near the customer's location, **only if authorized by a Geometrics technician. Any unauthorized repairs to the equipment will void warranty*. This warranty does not apply to damage caused by accident, abuse, misuse, misapplication, or service done by anyone who is not authorized by Geometrics to conduct repairs.** Geometrics will establish to its satisfaction that failures have not been the result of abuse or improper deployment of the system.

***Unauthorized repairs include the opening, modification, or tampering with any sealed container, such as the G-882 pressure housing. Failure to follow these instructions will void warranty and all costs related to the repair of the equipment will be charged to the customer's account. It is very important that you call Geometrics at (1) 408-954-0522 and speak to a Magnetometer Support Technician before attempting any repairs on the equipment.**

2.0 Quick Start Hardware Guide

The information in this and the following section is provided to help you get the magnetometer set up and running quickly and ensure that it is working properly. It can be used prior to any survey as a system check-out.

The cesium-vapor sensor is located inside the magnetometer pressure vessel and is situated at back of the tow fish in the cylindrical body that forms a 'T' with the long axis of the vessel. (see figure #1). The sensor is internally connected to the sensor-driver electronics and Larmor frequency counter circuit module located in the front end of the pressure vessel. External electrical connection to the sensor-driver module is made at the front bulkhead through a wet-mateable 8 pin connector.

It is important that the magnetometer fish be kept clean and free from magnetic contamination (iron or steel particles, rust). Never replace any hardware that has not been checked first for magnetic effect. We encourage you to use the tools supplied with the magnetometer to minimize magnetic contamination of the fish parts.

Begin by removing the sensor, tow cable, on-board deck cable (if purchased), white junction box, power supply and software USB from the shipping crate. Have your computer on hand for later software installation and system test.



Figure 1 G-882 Tow Fish with nose mounted echo-sounder altimeter housing

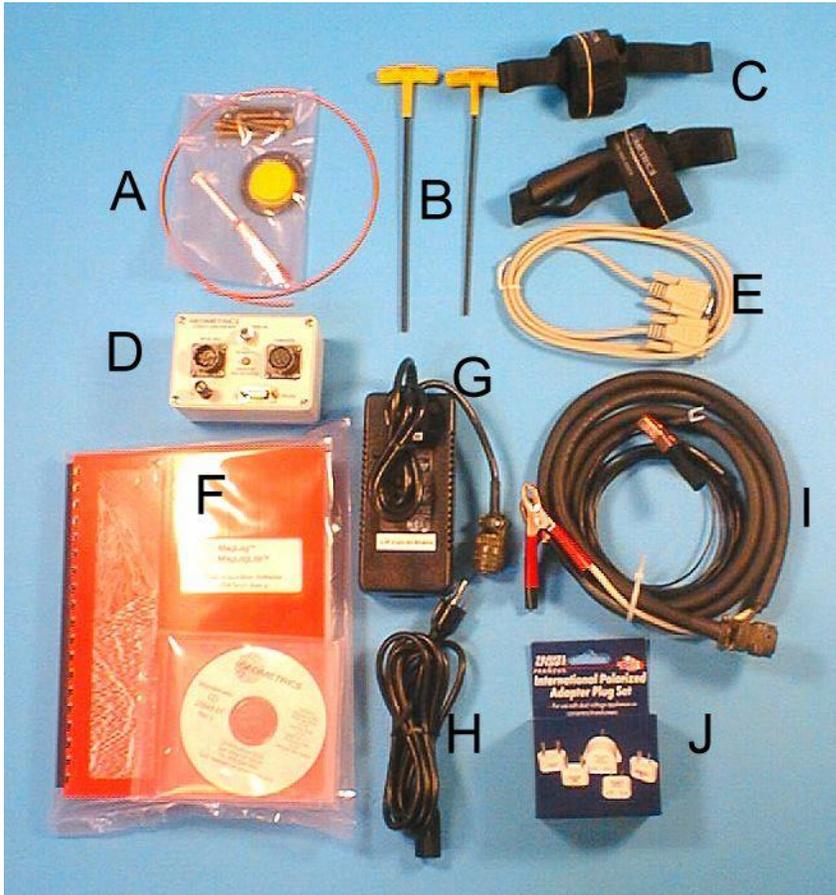


Figure 2 Accessory Kit

Fig 2 Accessory Kit: includes
A) O-Rings, silicone grease, non-magnetic brass screws, anti-seize compound in a plastic bag with trimmer string (to lock nose to body)
B) Allen wrench set
C) Cable tote ties
D) Junction box
E) RS-232 cable
F) MagLog Manual w/ software disk
G) AC/DC power supply
H) AC power cord
I) DC power cord (with battery clips)
J) Franzus international AC adapter plug kit.



Figure 3 Tow Cable Assembly, 200 foot (60m)

Set the magnetometer on a clean dry surface and unroll a 15 ft. (5m) section of the tow cable and bring it to the nose of the fish.

2.1 Nose Tow Configuration

The G-882 may be towed in either Nose Tow or CG (center of gravity) Tow configurations. Nose tow is used in shallow water deployment (or attachment to a Side Scan Sonar). Nose Tow configuration allows for stable towing up to 20 knots. We normally recommend Nose Tow for all applications for the sake of survey efficiency and safety.

CG Tow configuration allows for stable towing up to 5 knots. CG configuration is more commonly used when going deeper in the water column. While CG Tow configuration can get the fish deeper in the water column, it will only get the fish about 1-2 m deeper. Using a steel tow cable will better ensure that you reach the depth needed for your survey. We will discuss depth estimates later in section 4.6.3

In order to attach the tow cable to the front of the magnetometer the nose plug must be removed from the front of the nose piece. Begin by removing the top cover cotter pins and linchpins and remove the top cover (Figure 4A to 4C below).

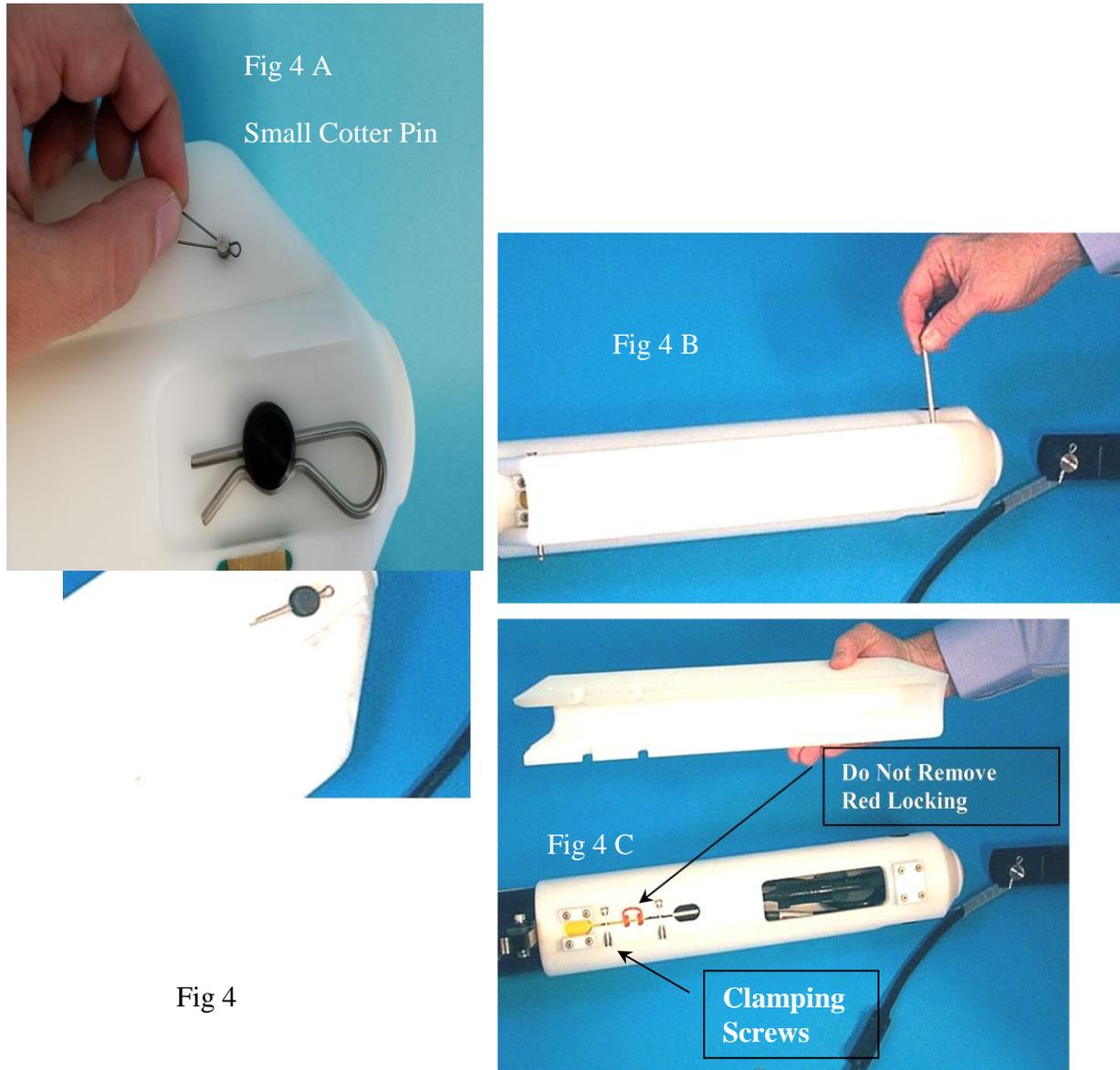


Fig 4

Note the orange locking strings and nose clamping screws at the rear of the nose piece in Fig 4C. Should you need to rotate the sensor tube (discussed under sensor orientation) you will loosen these screws and rotate the nose piece and weight relative to the sensor axis at the rear. **Never remove the orange locking strings unless you need to replace the nose piece.**

Next remove the nose plug hairclip pin, black clevis pin and nose plug from the nose assembly as shown in Fig 5 A to C. Store these parts in a safe place as you will need them when you convert to CG tow configuration.

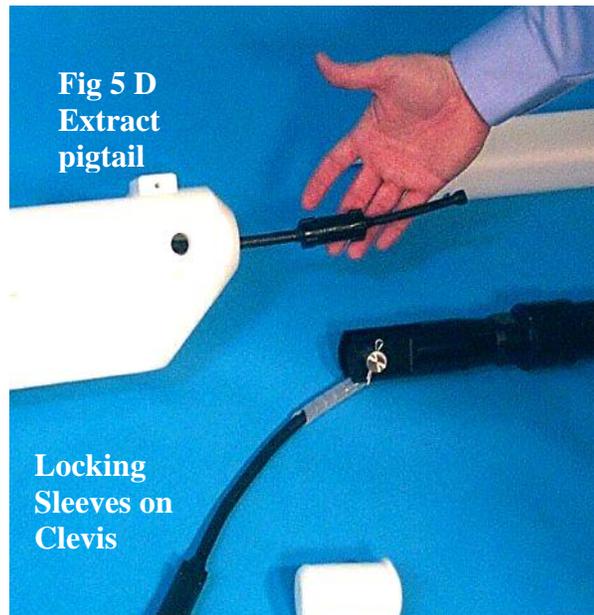
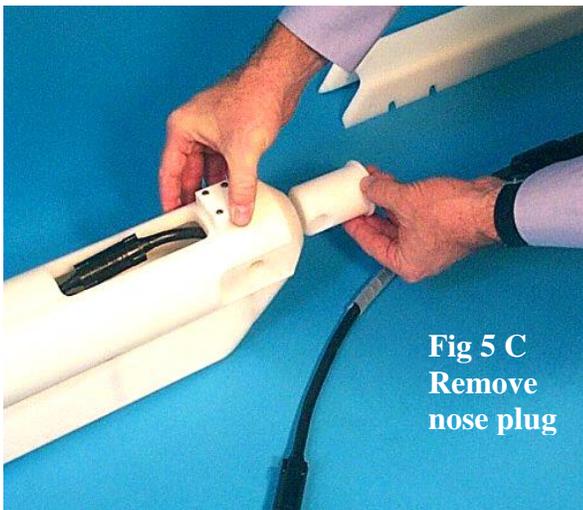


Fig 5

Next carefully pull the pigtail cable assembly from inside the nose through the nose hole (Fig 5 D) and remove the dummy plug. You do this by unscrewing the locking sleeves and pulling the dummy plug straight out. Do the same on the pigtail attached to the tow cable clevis termination.



Figure 6

Locate the silicone grease that comes with the ship kit (in one of the plastic bags, Fig 6, 7) and apply a very small amount of grease to lightly cover the male pins and female receptacles. Note that too much grease can interfere with proper mating and that grease need only be applied when connectors appear dry. Line up the two connectors and push firmly together until they seat (Fig 8). Do not bend the cables from side to side as you do this. Firm pressure is required. Screw the locking sleeves together to complete the electrical connection. Tighten finger tight and then give another 1/8th turn. Do not use pliers to tighten the locking sleeves.

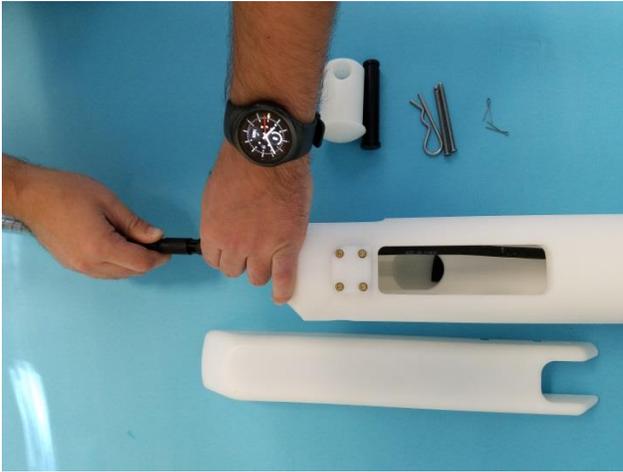


Figure 7

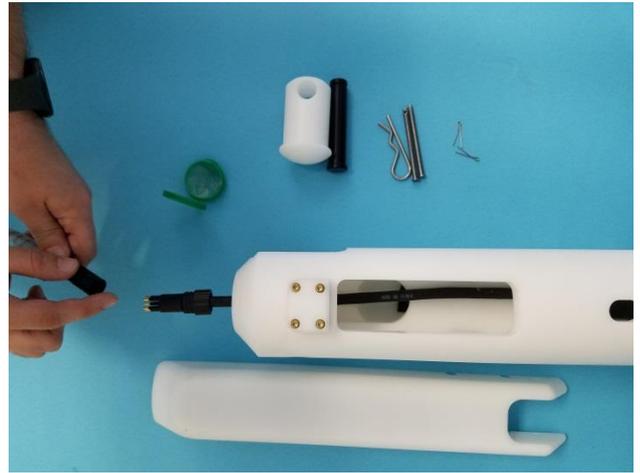


Figure 8

Now push the connected cables back through the nose hole and pull them up through the top cover port. Insert the tow cable clevis into the nose hole and secure with black clevis pin and hairclip pin. Complete the nose tow assembly by gently pushing the connected cables into the nose cavity and reassembling the top cover.

Pictures as shown include the optional altitude echo-sounder, your completed assembly may look different if this option is not included.

2.2 Converting Nose Tow to CG Tow

Converting from nose tow to CG tow is quick and easy. Remove the top cover and as shown previously (Fig 9), pull out the cable assembly and unscrew the connected cable assembly locking sleeves. Separate the cables by manually pulling them apart, straight out. Remove the hairclip pin holding in the black nose clevis pin, remove the clevis pin and then remove the tow cable assembly from the nose assembly by pulling straight out. Replace the nose plug, black clevis pin and hairclip pin that were removed in the first assembly process.



Figure 9



Figure 11



Figure 10

Next attach the tow cable clevis assembly to the tow point hole in the handle assembly using the stainless steel CG tow pin as shown and secure with a supplied cotter pin (Fig 10 and 11). ***Make sure you bend over the cotter pin with a pair of pliers when assembly is completed.*** Note that the pigtail cable assembly (shown with protective spiral wrap above) must exit the tow cable clevis termination as shown toward the front of the fish.

Next, inspect the male and female connectors to ensure that there is sufficient silicone grease and mate the connectors, screwing together the locking sleeves to complete the connection (Fig 12 A). Then gently push the connector pair and cables into the nose cavity (Fig 12 B). Feed the pigtail under the top cover and secure the top cover with linchpins and split rings. See Figure 12 C for completed assembly.

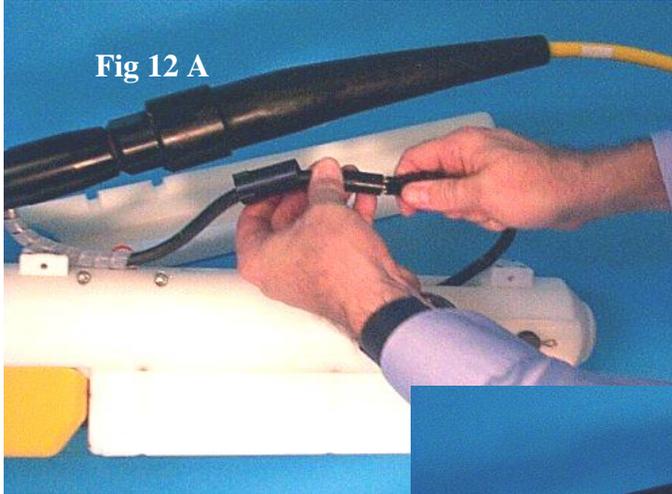


Fig 12 A

Figure 12
Final Nose Tow
Configuration



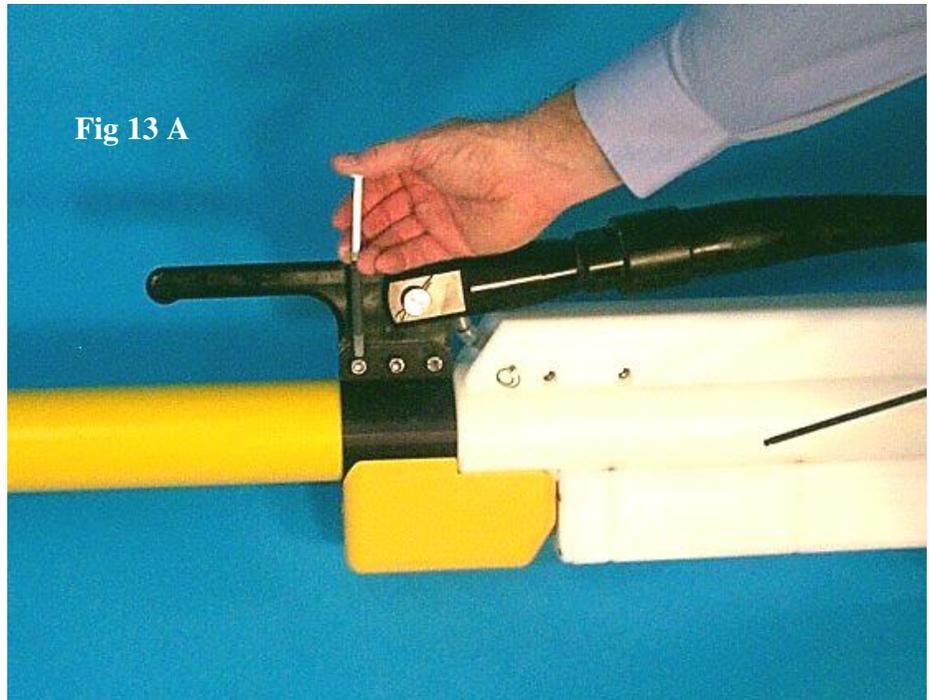
Fig 12 B



Fig 12 C

2.3 Adjusting Handle and Orientation Weight

Under some circumstances (surveying at the far north or south latitudes) it may be necessary to rotate the sensor housing by 45° or 90° (see section 4.3 on sensor orientation). To do this, loosen the three bolts holding the handle to the orientation weight collar and the clamping screws on the nose piece (Fig 13 B) and rotate the weight, handle and nose assembly by 45° or 90°. Before retightening bolts, apply some anti-seize compound that is supplied with the system as shown in Fig 13A.



Loosen these screws to also rotate the nose. **Do not remove the orange locking strings.**

2.4 Attaching the Tow Cable to the Vessel

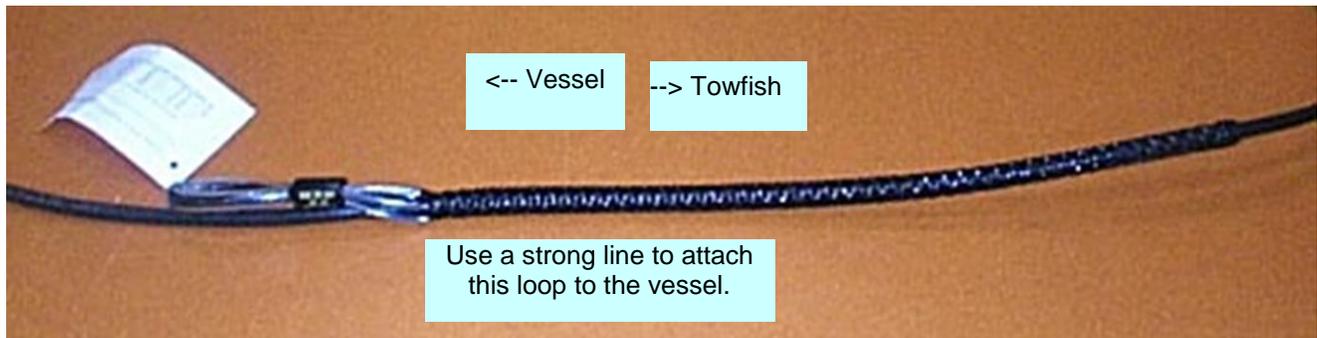


Figure 14

Each tow cable comes equipped with a Kellems grip for attaching the tow cable to a strong tow point on the tow vessel. Slide the Kellems grip to the position on the tow cable that will allow you to deploy the magnetometer to the desired distance. Attach the Kellems to the tow cable by wrapping vinyl adhesive (electrical) tape around the free end (end without the loop). The tape should be started on the cable and lap onto the Kellems. The wrapping should be applied in several layers as show in Figure 14. **DO NOT** tape along the whole length of the Kellems; this will prevent it from working properly.

Tie the loop end of the Kellems to your vessels tow point with a strong rope prior to casting the magnetometer overboard. The line and or hardware used for towing should be rated to meet or exceed the 4000 lb. breaking strength of the tow cable. In addition, the tie-off point should have a similar static load rating. Additional discussion of appropriate tie points will be found in section 4.6.2.

2.5 Powering Up the System

Connect the tow cable to the DC/Data Junction Box (via onboard deck cable if purchased) and fix the tow cable to the tow vessel. Determine whether you will use AC power or DC power. The AC supply will accept 120/240 VAC and there is an adapter plug kit supplied for various international plug styles.

If you elect to supply DC power via two 12 volt batteries in series, note that a minimum of 24VDC must be presented to the Magnetometer. Therefore 26 to 28VDC may be required at the junction box depending on cable length. Typically fully charged batteries present about 13 volts each, and so this should function well. Discharged batteries may not have enough voltage to start the magnetometer although keeping it running once warmed up requires less voltage. The DC Power Cable is provided to connect to battery power

With all of the components of a system connected, apply power by first turning the AC supply on. There is a switch next to the mains power entry connection. If DC power is used, hook up the batteries and DC cable. Connect to the junction box.

Next, turn the Junction box DC power switch on using the locking toggle switch on the junction box. The power indicator will light up green if the DC input polarity is correct. If the DC input is derived from a battery set, there is the possibility of accidental reverse connection of the power. If this should happen, the power indicator will light up red, but no damage will occur. In this case, turn off the junction box switch and recheck the DC power connections.

When power is applied, after a short warm up period (1 to 2 minutes), the magnetometer will begin producing data. The default transmission protocol from the CM-221 counter in the G-882 Magnetometer will be RS-232 at a 9600 Baud rate. After about 2 to 5 minutes, the output from the magnetometer will be stabilized and can be observed using HyperTerminal supplied with Windows or MagLog software. See the section under Troubleshooting (section 5.5) on how to set up HyperTerminal.

Under some circumstances you may get better data if you connect the ground lug on the DC/Data Junction Box to the ship's hull using a ground cable. (Typical noise levels at sea will be under 0.2nT peak-to-peak and may be less than 0.1nT depending on sea state, ocean waves can generate magnetic signals). This connection may be required if the AC Mains power is grounded to the steel hull. See troubleshooting section for more information.

Connect the Logging Computer to the DC/Data Junction Box using the RS-232 Serial Data cable provided. See Figure below.

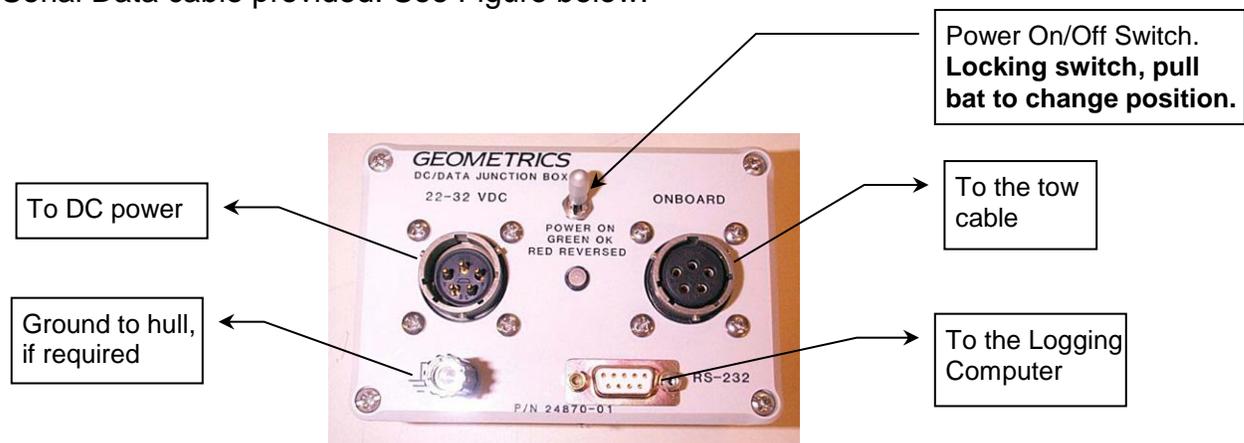


Figure 15

3.0 Quick Start Software Guide

This section of the manual refers specifically to the installation and setup of MagLogLite or MagLog PRO (NT), Geometrics data logging and display programs. We use the terms MagLogLite and MagLog interchangeably to refer to the logging programs made by Geometrics; differences in performance between MagLog and MagLogLite are not important for our discussion here. If you are using another logging program such as Coastal Oceanographics Hypack™

please read the first section below for tips on getting a good signal from the magnetometer on board ship before setting up the software.

A cesium magnetometer will operate inside a room or lab or on the back deck of a ship as long as two criteria are met. First, the sensor must be oriented as it would be if it were being towed. In other words, for most survey areas the sensor tube cylinder (at right angles to the main sensor tube body) should be positioned vertically so that the long axis of the “T” is pointed up (see CSAZ program). Second, the sensor must not be within a few feet of large steel objects such as winches or steel decks. If the towing vessel is steel, place the sensor assembly on top of the white shipping crate or plastic drum to get it 3 to 4 feet above the steel deck. On very large steel ships you may need to move the sensor to the wharf area or deploy it a short distance aft to get sufficient distance from the steel structure.

MagLog and other logging programs require positioning information to operate properly. We strongly recommend that you have your GPS turned on and transmitting data during the software initialization process. MagLog uses the standard \$GPGGA string that all current GPS receivers transmit. Most modern computers no longer support direct serial communication ports, but all do support USB (universal serial buss) ports. We suggest that you purchase (from us or directly) a Keyspan™ 1 or 4 port Serial to USB converter unit and have it installed on your computer. This will provide one or more serial ports for use with the magnetometer system. For the G-882 system you will need two serial ports, one for the GPS and one for the magnetometer.

At this time we also recommend that you install the MagLog printer port software key (also referred to as a “dongle”) that will give you access to the MagLogLite data logging features. MagLog and MagLogLite will install from the CD but will run in demo mode unless and until a printer port key dongle is installed on the PC printer port. In case of trouble, Customer Service at Geometrics can give you a temporary software key code to type into the computer and get you running.

Install MagLogLite from the supplied USB or download from our website, www.geometrics.com. Insert the USB and follow the menu selections to install MagLog / MagLogLite. The dongle will determine which version of the program initializes. Note that for most surveys, MagLogLite provides all the features you will need. MagLog is used primarily in airborne surveys and with USBL tracking systems.

With the sensor properly positioned turn on the power switch on the white junction box. A green light will indicate proper power connections; a red light indicates reversed polarity on the DC voltage input. Turn on the computer and click on the MagLog icon on your desktop. Ensure that the GPS is running and the G-882 junction box shows a green power light.

3.1 What Does MagLog Do?

MagLog is a sophisticated data logging and display tool that has a large number of customizable features. These features include but are not limited to the following:

- Automatic calculation of fish position in real time (interpolation)
- Automatic anomaly detection and Lat/Long position flagging
- Plotting of GPS ship track, fish position and data on the map
- User setup of survey grid area with survey lines to show which survey lines have been completed on the GPS track screen
- Automatic start stop of logging when sensor is in survey area
- Multiple “slots” with multiple “pens” so that many different kinds of data can be displayed simultaneously. Arithmetical operations like Depth + Altitude to show water column; gradient calculations
- Survey playback at high speed to search for anomalies

There are many more features but the purpose of this section is to show how to set up MagLog and quickly begin logging data. For this purpose we use the Survey Wizard which you will find listed under File on the MagLog menu bar. Click on File and then on Survey Wizard (see Figure 16 below). After the introduction screen is displayed, click “Next”.



Figure 16

3.2 The Survey Wizard

The Survey Wizard will take you step by step through the initialization process to set up the GPS, magnetometer, real time layback calculation (interpolator), printer and depth and altitude sensors (if included).

The next screen asks us to define a new survey name. In this case we have used "test.survey" as our survey name. Note that the program creates several files based on this root name, including files for the GPS, for the magnetometer, a file for the line number, another for the Interpolator, which is the file with the actual relocated fish positions. Type in a name and click next (Figure 17).

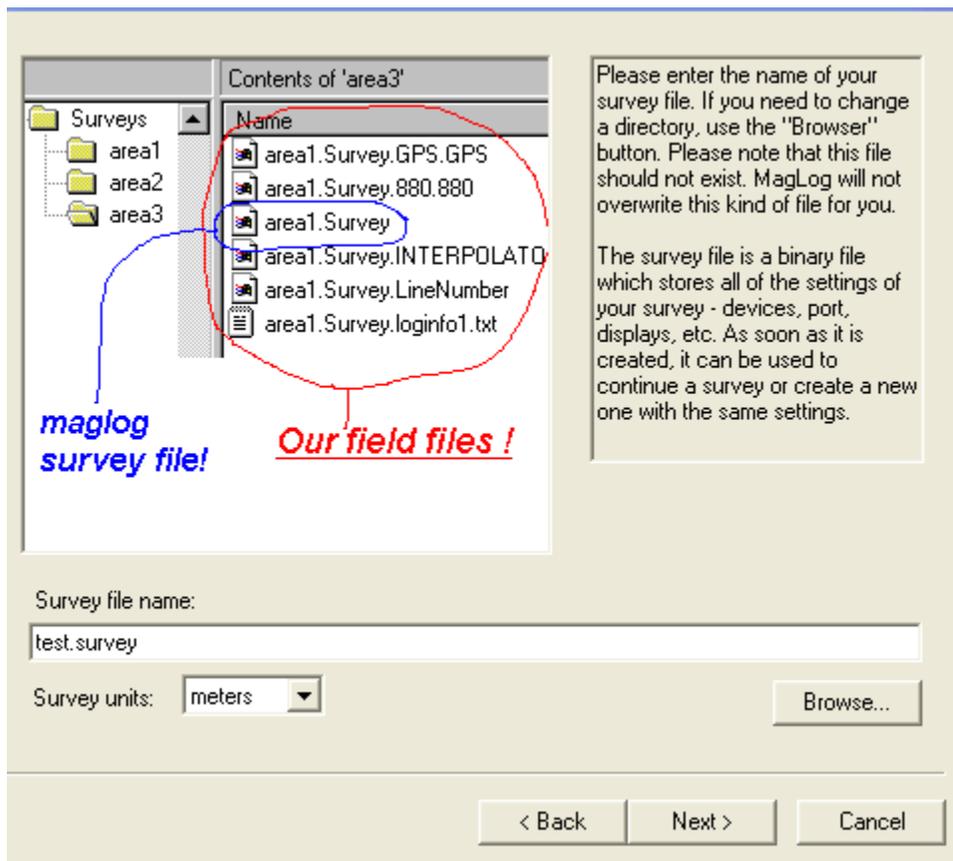


Figure 17

The next screen shows the GPS communication setup parameters. You should have the GPS connected and sending data at this time.



Figure 18

Set the Port to the proper number and baud rate value (if you do not know this information the program will scan for it) and then press the “Autoset communication parameters” button. When the program detects the GPS it will report back as below:



Figure 19

The next screen offers a facility to import Arc Info shape file maps. This is a feature covered in the MagLog Manual and for later discussion. Press next.

Figure 20 shows the magnetometer setup screen. As before, if you know the name of the communications port the mag is using and the baud rate (default 9600 baud) set it now. Otherwise the program will search for the connection. Select the type of magnetometer you have where 88x stands for all marine

magnetometer systems. Essentially we are selecting one mag, or one mag with depth sensor or one mag with depth sensor and altitude echo-sounder (or two mags for gradiometer array). The cycle time is set in tenths of a second, e.g. 0.1 means 10 samples per second, which is the system default. Click on “Autoset communications parameters” to interrogate and set up the magnetometer communications.

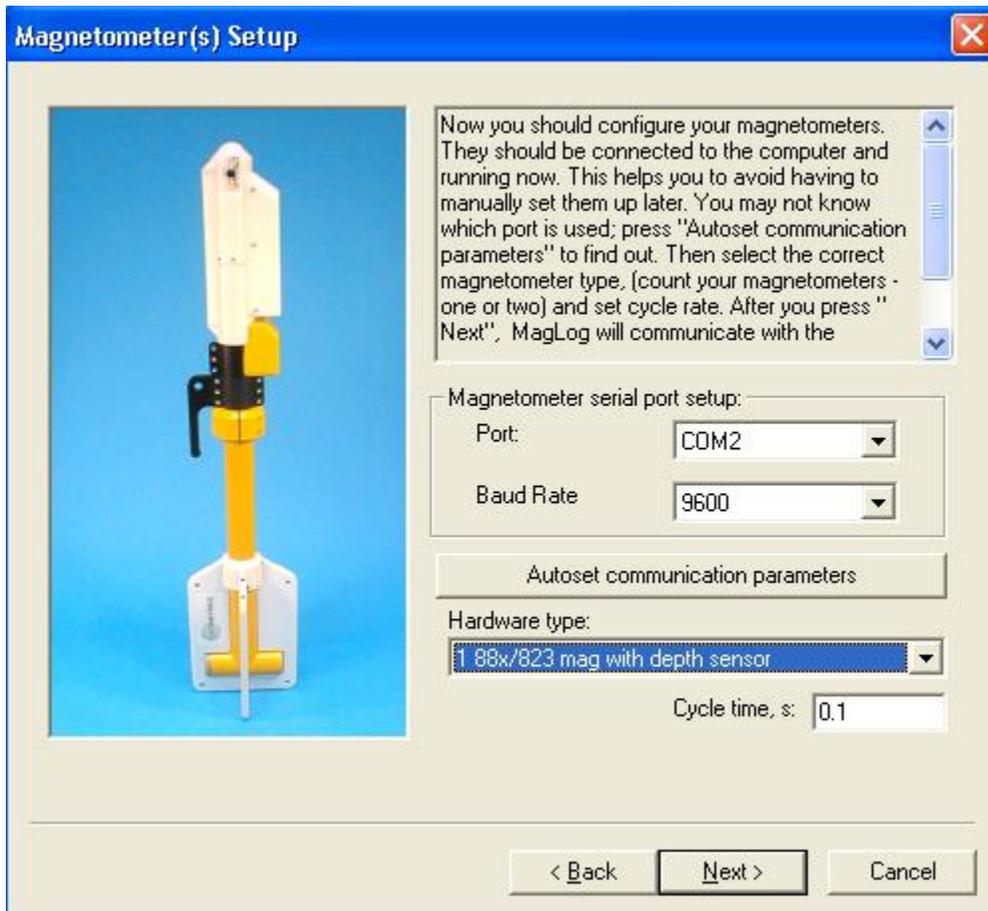


Figure 20

You will get a screen as shown in Figure 21 while the magnetometer is being detected. You will be notified when the magnetometer is communicating and setting the analog channels (used for depth and altitude). Note that the 1st analog channel is always reserved for magnetometer signal strength. Therefore, if you have 1 and 2 shown in this screen, 1 is signal strength and 2 is depth transducer.

At the bottom of the screen is a button named Store Configuration. When this button is pressed, the default settings (power-up default parameters) are loaded from MagLog into the magnetometer CPU Flash memory. This means that you can change how the magnetometer initializes so that it will wake up with the proper number of channels turned on and the selected cycle rate, etc. If you make changes to the magnetometer operation and wish to store them permanently in the Flash Memory, use this button. You can change the stored parameters at any time.

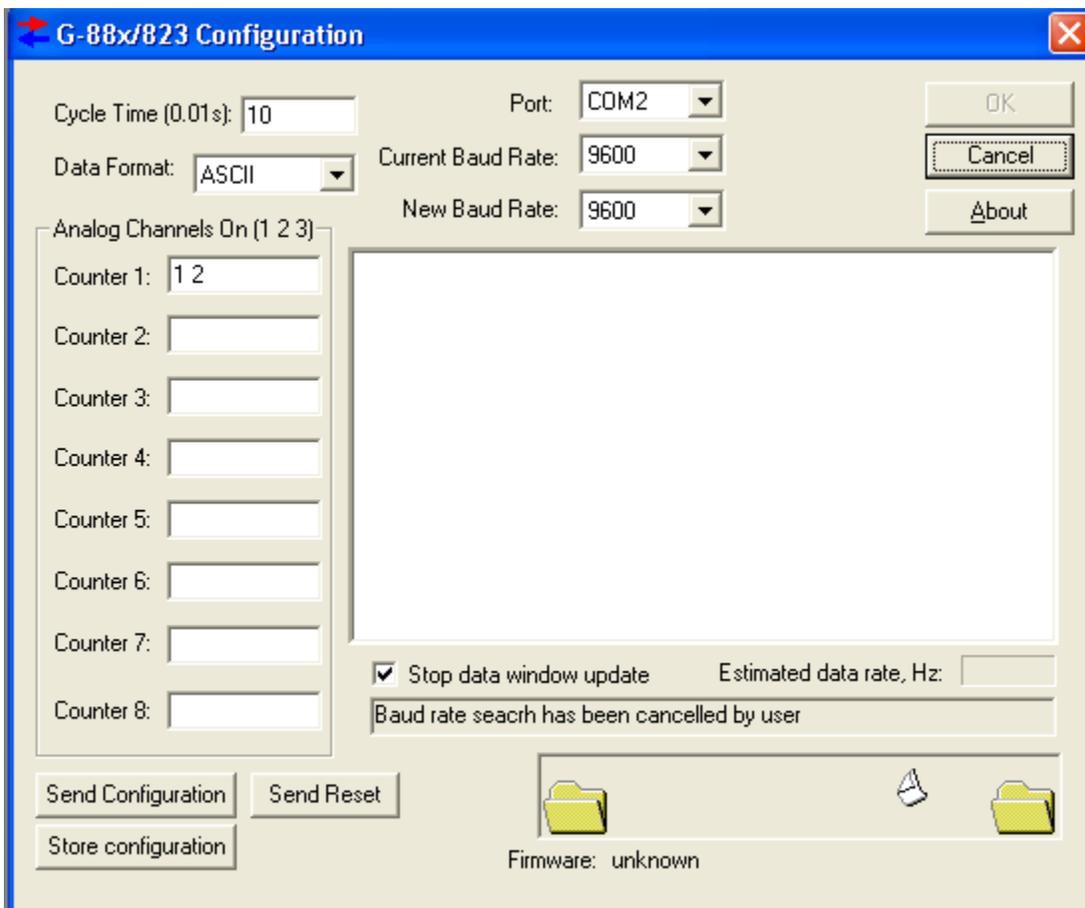


Figure 21

The next screen enables the user to enter the calibration coefficients for either the depth sensor, altitude echo-sounder, or both. These coefficients are found on the tailfin of the magnetometer and in the accompanying documentation.

For the depth sensor calibration, enter the scale and bias information for the type of water in which you will be surveying (different scales and biases are supplied for saltwater and fresh water surveys). If you have an echo sounder altimeter installed, enter the scale and bias information for that accessory as well. When you have completed entering the data, click next to continue. (See Figure 22)

If you do not have the calibration coefficients for your system, you may use the manual calibration facility included in MagLog. This feature is accessed from the configuration menu for the particular device and will be covered later in this manual under section 2.5.5.

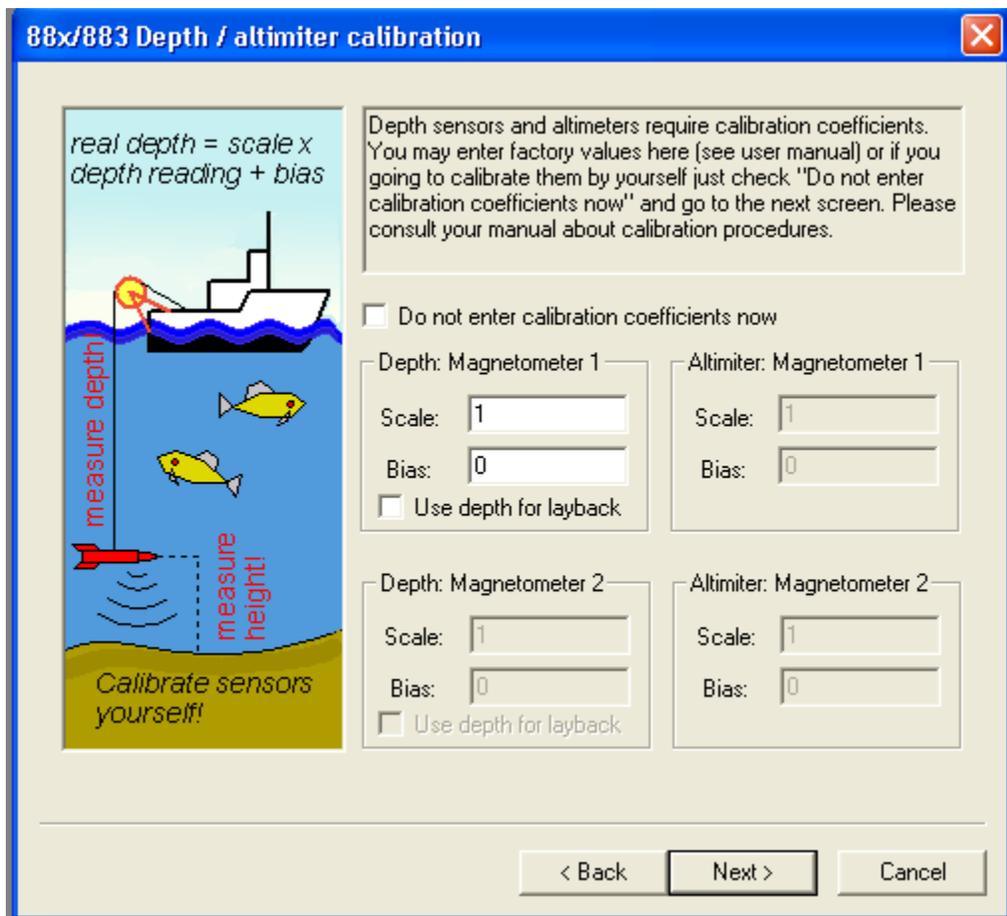


Figure 22

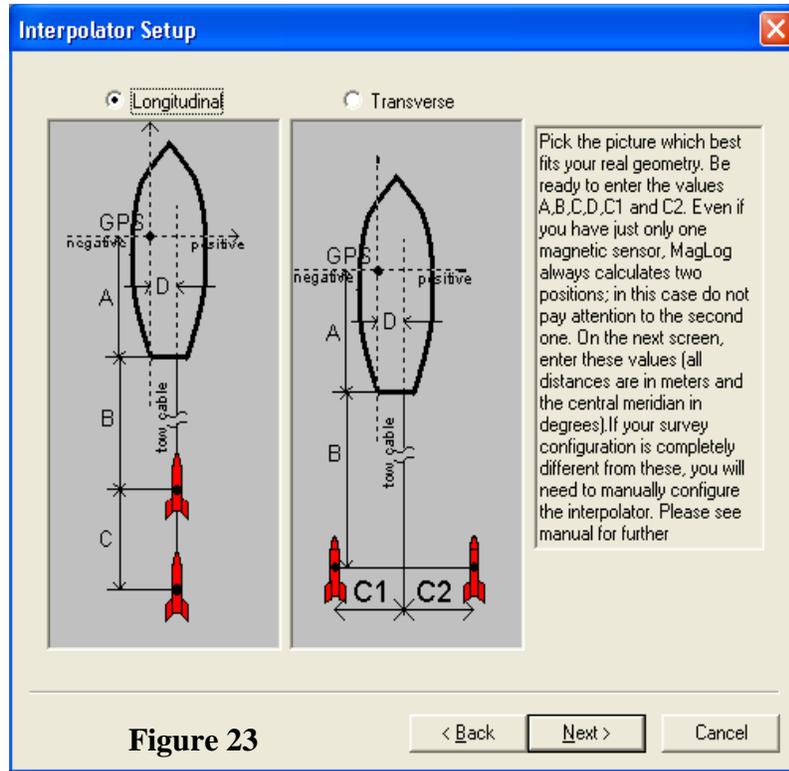
The next screen presented will set up the Interpolator feature. The interpolator does the following:

1. Uses the GPS antenna latitude and longitude information and converts it to UTM coordinates in meters.
2. Based on user input in this section (offset of antenna from tow point, length of cable deployed), the program computes the position of the fish in UTM coordinates. MagLog employs a proprietary “dragging algorithm” which analyzes the track of the boat and makes a best estimate of the position of the fish based on the physics. The computed UTM fish position is then recalculated in Lat/Long and that information stored in the Interpolator file (*.int).
3. This process occurs at 10 or 20 times per second (Hz) so that the position of the fish is computed and stored with every reading. Because the GPS information typically comes at 1 or 2 Hz, the position of the fish is interpolated in between GPS fixes. This is why the feature is called the Interpolator.
4. Addition of a heading Compass or Gyro greatly improves the computation of the fish position. This is because when the ship is pointed in a direction different from the direction of travel (due to side currents) the currents also affect the position of the cable and fish system. MagLog will log common

Gyro and Fluxgate Compasses for automatic correction of side currents.
Contact Geometrics for more information and a case study.

To use the Interpolator feature, click the button that says “Yes, I want real time layback calculation”.

The Survey Wizard provides set up of the Interpolator to calculate the positions of one or two sensors (more “fish” may be added later) in real time. If a gradiometer array is being deployed, the sensors may be configured in either a longitudinal (one behind the other) or transverse (side by side) manner. You have the option of putting in information to describe either configuration. For typical one sensor surveys, use the longitudinal configuration button.



For a single sensor installation you will be defining the geometry by entering information regarding distances defined by A, B and D in the left of Figure 23 above.

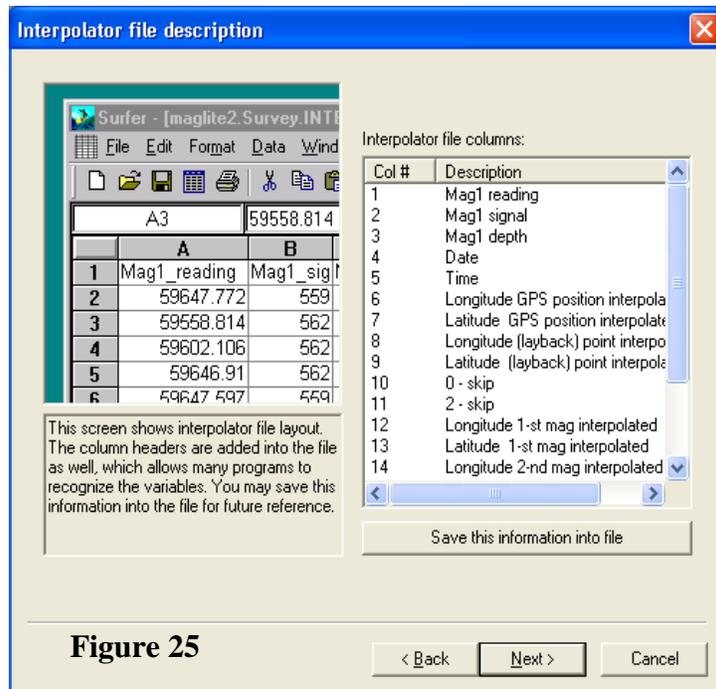
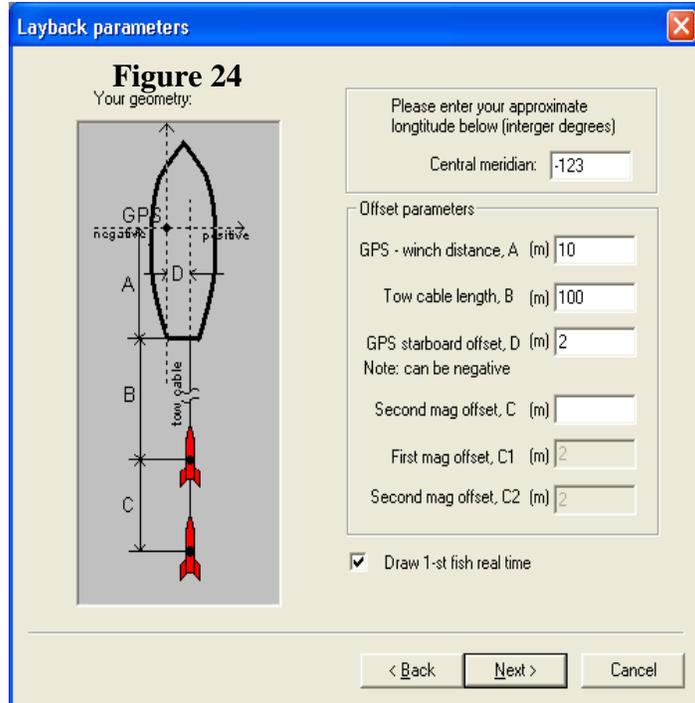
Enter data as shown in the Figure 24 below to define the position of the GPS antenna relative to the tow point on the back of the ship, and the amount of cable deployed. MagLog will then interpolate and calculate the fish position in Lat/Long in real time for the purposes of drawing the fish position on the GPS screen during actual survey (make sure you click the box that says “Draw 1-st fish real time”). In addition, this information is used to flag anomalies that exceed your preset anomaly detector criteria set up in the “Configure Input Devices” described later. A table of these anomalies may be exported for direct import into programs like Geosoft, MagPick and Surfer to show the location of the targets. This is of course much better information than simply the location of the boat at the time the fish passed over the anomaly. Now the user can steer the boat using the GPS, back to the calculated location of the fish when the anomaly was detected.

Put a “0” in the “Second Mag offset” if there is only one tow fish deployed and two are shown (Figure 24). Recent versions of MagLog will have only the number of fish displayed that are logged, however your program may show two fish. Make sure you have the latest version from our website.

The next screen in the Survey Wizard shows the user how the Interpolator file will be generated. Note that all relevant data is stored including magnetic field, signal strength, sensor depth and altitude if available, GPS position, fish 1 and fish 2 position, etc. This file may be brought directly into MagMap using the “all files” input description in order to plot the actual fish positions for further analysis (Note: bringing in MagLog *.survey files [pertains to MagLogLite as well] give ship position plots, not sensor position plots. Only bringing in Interpolator files will show the actual calculated fish position on the GPS track plots in MagMap.

You may save this header file for future reference using the “Save this information to file” button.

Next the Survey Wizard will help us define the look and feel of the logging display (Figure 26). We are presented with certain default “slot” line colors and plot definitions. We recommend that you use the Horizontal (Landscape) display mode and that you accept the basic wizard color definitions at this stage of set up. You can always change these items later during program operation.



Slots are defined as subsets of “Windows”. Windows may have one or more slots and in each slot there may be one or more pens. Pens may represent such things as depth in meters or magnetic field with 200nT full scale and a second pen in the same slot with 20nT full scale. Configuration of these parameters are covered in more detail in the MagLog manual.

The next screen shows the Slot Display parameter controls (Figure 27) which set the full scale value, grid settings and chart speeds of the graphics presentations. We recommend that you just accept these parameters as defaults for now. Again, these can be easily changed once the program is running.

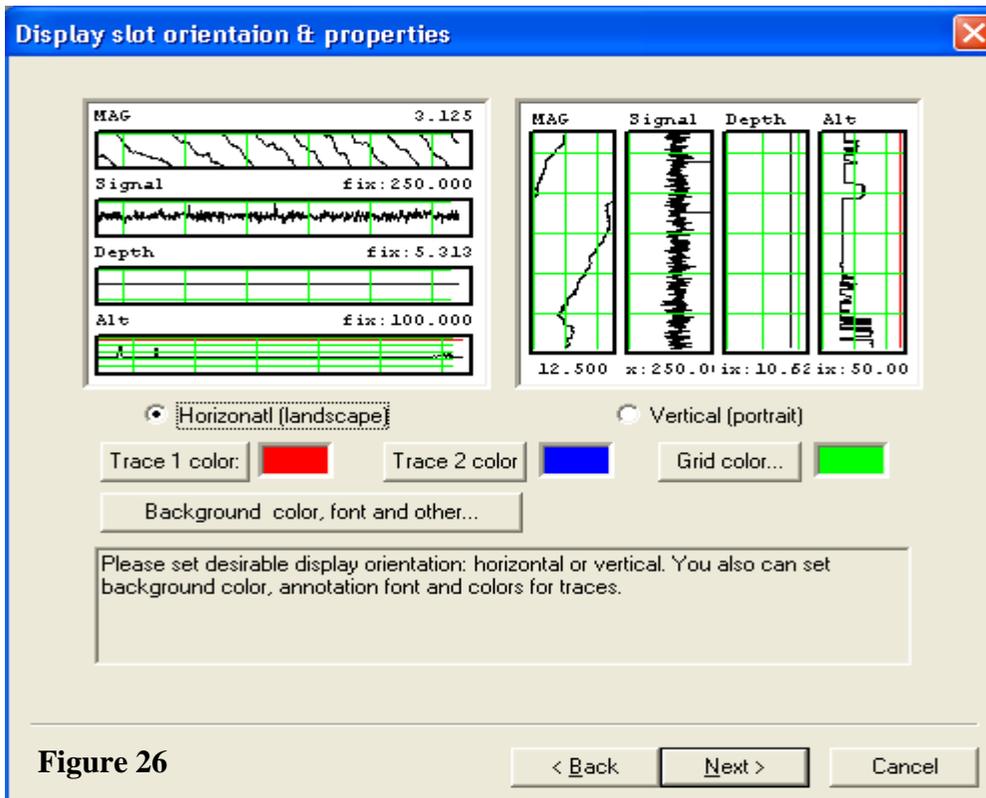


Figure 26

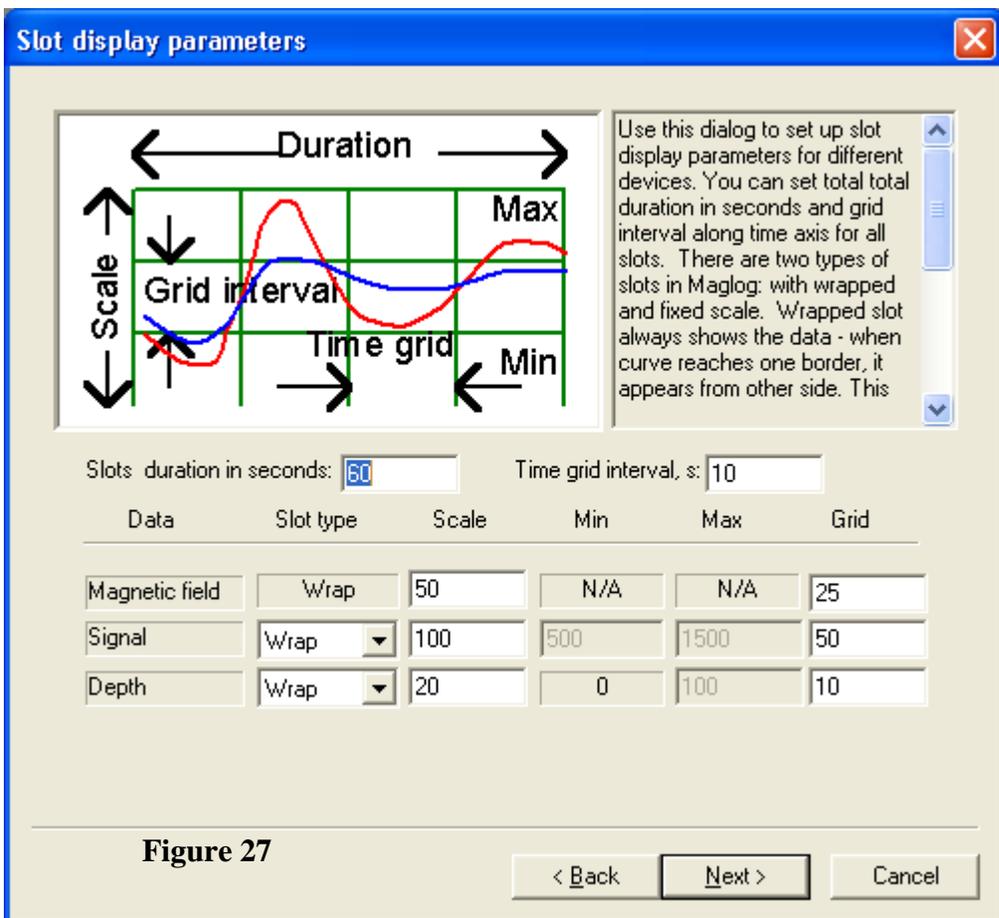


Figure 27

The Survey Wizard now asks us to set up either a dot matrix printer or laser/inkjet Windows printer for making hardcopy of the data on site. Note that if you do not intend to make printouts in-field plots of the data, you do not need to set up this feature. Of the two types (dot matrix and Windows™ laser/inkjet printers), we recommend the user of the Windows™ printers (see next screen, Figure 29). The reason is that

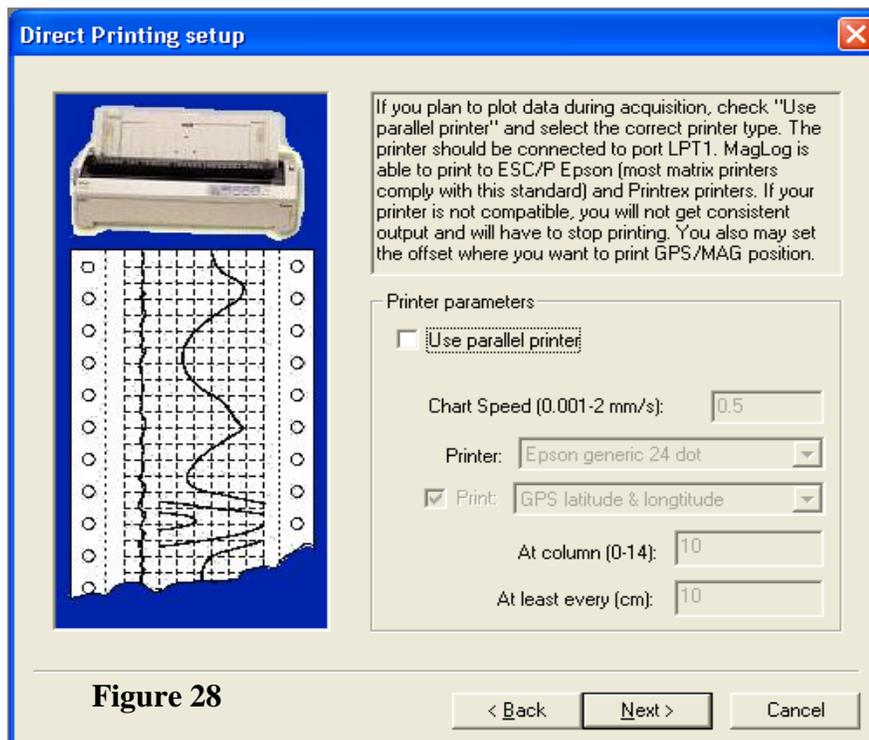


Figure 28

while dot matrix printers use continuous roll paper and can plot the entire survey in one profile, the Windows™ printers may be configured to print on anomaly only. Thus when an anomaly exceeds the preset values it will be printed with positions and other data as selected on the center of an 8 1/2 x 11 inch sheet.

Note that when you configure the “Windows” printer, you must have the printer connected to the computer or network and turned on.

This completes the Survey Wizard dialog boxes and this Quick Start Software section. Clicking on the final screen of the Survey Wizard will start the survey. Note that the program starts in display mode only, and that in order to log data you must use CTRL-S to start logging the data (or File – Start Logging).

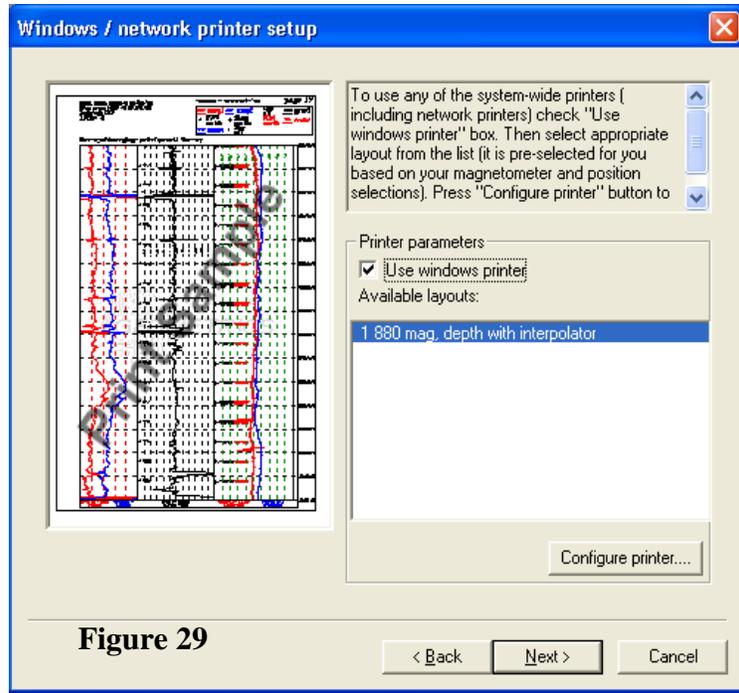


Figure 29

The following sections deal with deploying the sensor in different latitudes and technical data regarding data formats. The final sections include a troubleshooting guide and contact information.

4.0 General Overview

The G-882 Marine Magnetometer consists of two modules: sensor and sensor driver electronics module mounted in a fiberglass pressure vessel. The G-882 sensor driver module contains a CM-221 frequency counter which is used to count and digitize the Larmor frequency. The counter then transmits the data in digital RS-232 format up the tow cable.

A basic description of the physics employed in the G-882 Marine Magnetometer, and optically pumped resonance magnetometers in general, is included in Appendix A under Cesium Vapor Magnetometer Theory.

4.1 Operation and FAQ

The G-882 Marine Magnetometer is usually purchased with Geometrics logging software package **MagLog-Lite™** or **MagLog-PRO™**. Please refer to the Manual associated with this software for complete instructions regarding installation and setup. If **MagLog-Lite™** or **MagLog-PRO™** are not purchased, other serial port

logging software or terminal software may be used to communicate with the G-882. Refer to the front of this manual for the **Quick-start G-882 Hardware and Software Operating Instructions** to help with the initial setup and running of the magnetometer.

We receive many common questions about how to operate the G-882 magnetometer and we offer a few of them here for your review:

A. What is a good boat speed? Is there a maximum or minimum?

Most surveys are conducted at between 4 and 6 knots. The speed of the vessel will control the depth of the sensor fish because the drag of the cable dominates. Therefore higher speeds mean a more shallow tow. The tow cable is rated for 600 lbs. continuous working load. Short tow cables (less than 500 ft.) can be towed at up to 10 knots.

B. I want to tow 200 ft. deep, what are my options?

MagLog includes a tow depth estimation option, even in demo mode so anyone who has the program installed can utilize this function to estimate the tow depth. Go to Configure.../ Tow Depth Estimation... and here you can choose your instrument, tow cable type, tow speed and additional cable. Please keep in mind that these are estimates and should be used with caution, especially in shallow waters.

A previous online version of the Tow Depth Estimator is show below. A quick calculation will show you that getting your sensor to 100 feet depth (30m) is not too difficult but to get beyond that depth, it will require significantly more cable, slowing down the survey and adding weight collars to the fish. Each weight collar is 14lbs. To get to 100 ft. (30m) depth will require 500 ft. of Kevlar cable, towing at 3 knots with 1 extra 14lb collar weight. Moving to 4 knots will raise the fish to a depth of 75 feet (25m)!

Tow Fish Depth Estimator

Warning: results are only approximate. Use this only as a general guide
Actual tow depths may vary considerably!

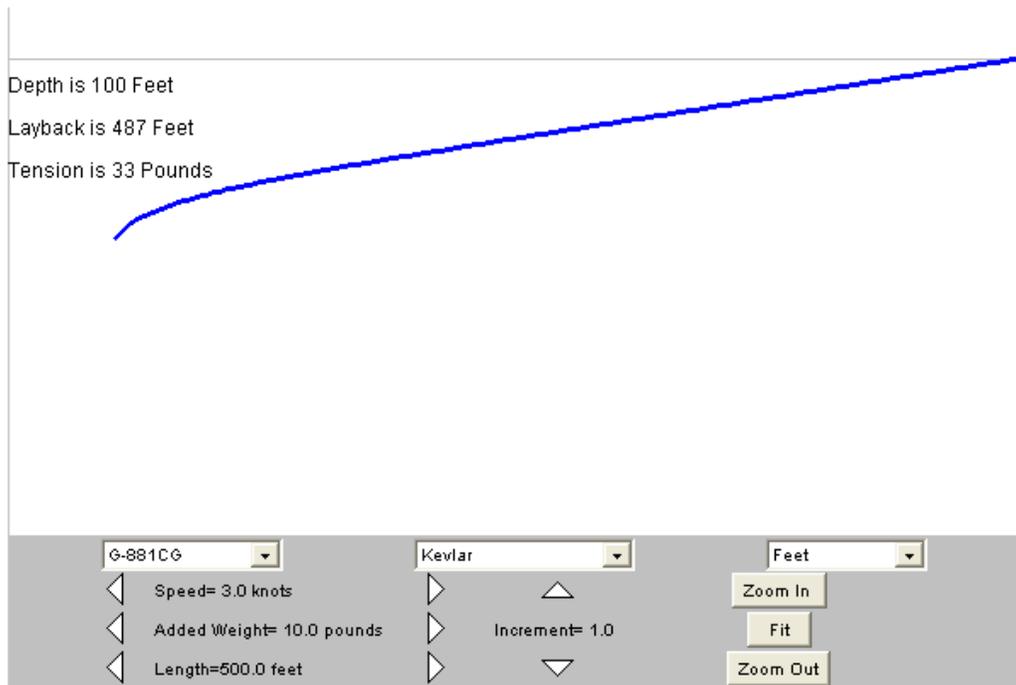


Figure 30

To tow very deep we offer steel armored coaxial cable with a telemetry system and high voltage power supply. This system can operate over 6 to 10 Km of steel coax cable.

C. How tight a turn can I make?

Tight turns remove the forward tension on the tow cable and therefore allow the sensor to sink. The tighter the turn, the longer the cable and fish will be without forward motion. Long cables will also lengthen the sink time. We recommend keeping the sensor under forward motion by performing an eye-bolt type maneuver or using a racetrack pattern (line 1, line 6, line 2, line 7, etc.) to keep forward progress.

D. Isn't Cesium radioactive?

There are certain isotopes of cesium that are radioactive, but we do not use radioactive isotopes in cesium magnetometers. We use extremely small amounts (micrograms) of the pure elemental metal which is non-radioactive and essentially non-reactive in those amounts.

E. How far can the magnetometer “see”?

Total field magnetometers like the optically pumped cesium magnetometer are passive devices, they do not send out waves or pulses. They measure distortions in the earth’s normally homogenous magnetic field and can sense distortions due to ferrous objects at great distances.

The basic rule of thumb is that one ton (1000 Kg) of steel or iron will give us a 1nT anomaly at 100 ft. or 30m. Since the amount of distortion falls off as the cube with distance (compare a metal detector which falls off as the inverse 6th power!) and is linear with mass, every time we cut the distance in half, we can see 1/8th the mass. Therefore, we can sense 250 lbs. (100kg) at 50 feet (15m), or 30lbs (15kg) at 25 feet (8m), or 4lbs (2kg) at 12 feet (4m). However this is not the whole story. The factors given above are for induced magnetic fields only. Many targets also have remanent or permanent magnetic effects (meaning they have become magnetized either in production or by the earth’s field) and can therefore have larger anomalies by a factor of 3 or 5 or more. Also many hollow objects like barrels or other tubular structures appear as though they are solid due to self-shielding from the earth’s field, and thus have much larger anomalies than their mass would predict alone. Pipes fall off as the inverse square and are thus detectable at even greater distances. Please see our Applications Manual for Portable Magnetometers for more information. Our website contains additional FAQ questions.

4.2 Performance

Geometrics G-882 magnetometer produces a Cesium **Larmor** frequency output at 3.498572 Hz per nT (in this text, nT refers to nanotesla or gamma or 10⁻⁵ gauss). Thus, in a nominal 50,000 nT field this frequency is about 175 kHz. The output of the system is a continuous sine wave at the Larmor frequency. The typical signal amplitude is approximately 2 volts peak-to-peak at optimal orientation of the sensor.

This frequency is counted with the internal counter at 10 readings per second but the cycle rate can be set to one reading every 1 second to 25 readings per second. The G-882 is intended for use in marine applications, and operates over the earth's magnetic field range of 20,000 to 100,000 nT.

Absolute accuracy (relative to National Bureau of Standards facility at Fredericksburg, VA) depends on sensor orientation, internal light shift and the accuracy of the external counter's time base. Typically cesium magnetometers offer absolute accuracies to within ± 2 nT of this standard. Since the offset if any is constant (no drift over the lifetime of the product) this is of no consequence in survey activities. Orientation error of the G-882 does not exceed 1 nT p-p (peak-to-peak) throughout the entire 360° polar and equatorial spins of the sensor.

Like all magnetometers, performance of the G-882 in a mobile installation is primarily dependent upon the stability of the tow fish and the proximity to large steel objects (e.g., the tow vessel). Navigational or positional errors radiated electromagnetic noise and heading error from the ship's induced and remnant magnetic fields are typically the major contributors to "noise" in the marine environment.

The G-882 Sensor Package consists of a sensor head and sensor electronics package joined by a cable. The electronics package contains an integral Geometrics CM-221 counter which converts the Larmor signal into a magnetometer reading in nanoteslas. Digital data is transmitted via RS-232 to a data logging system. An eight pin underwater connector on the sensor electronics package receives power on two pins. Three pins are used to provide an RS-232 connection upon which the G-882 transmits magnetometer data readings in digital format. The other pin(s) are reserved for future and special uses.

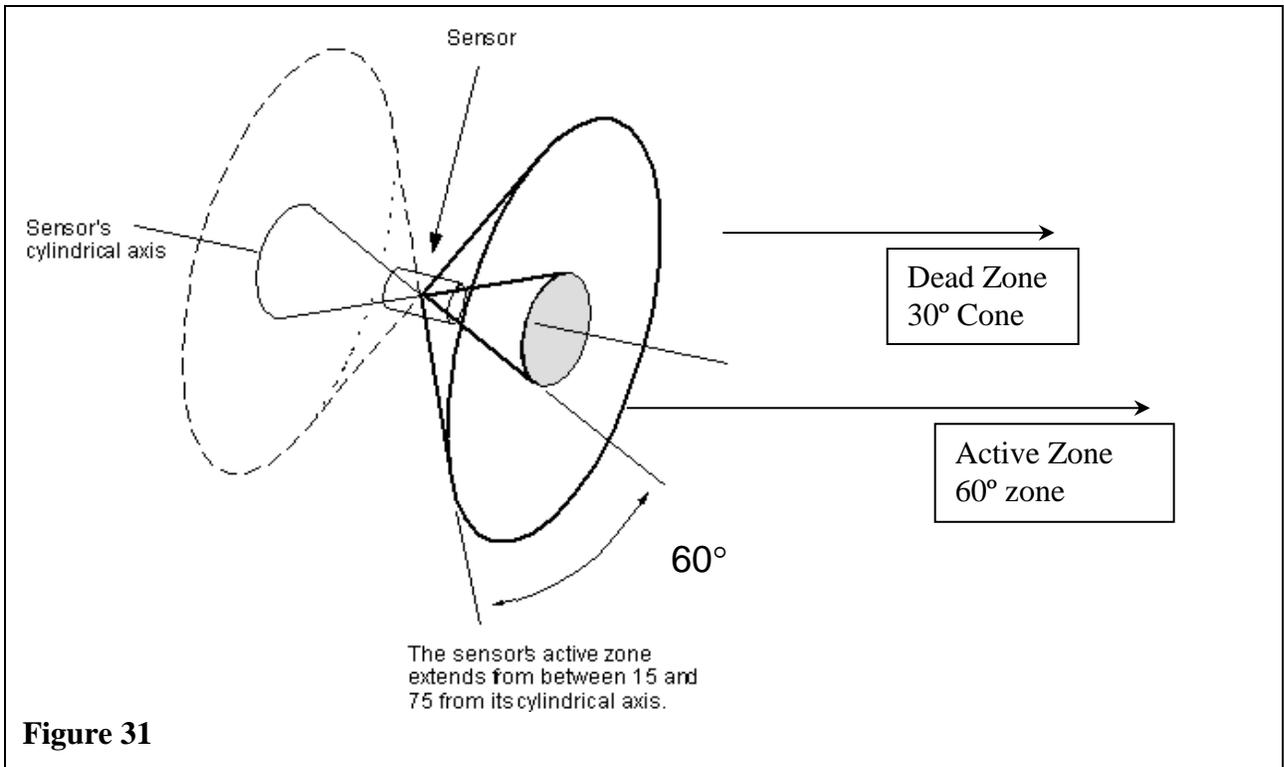
Environmental conditions for proper operation are -35 to +50°C (-31 to +122° F). The G-882 will operate to a depth of 4,000 psi (\approx 9000 ft.). Note that this depth can be reduced by the maximum pressure of an installed depth measurement option.

4.3 Sensor Orientation Guide

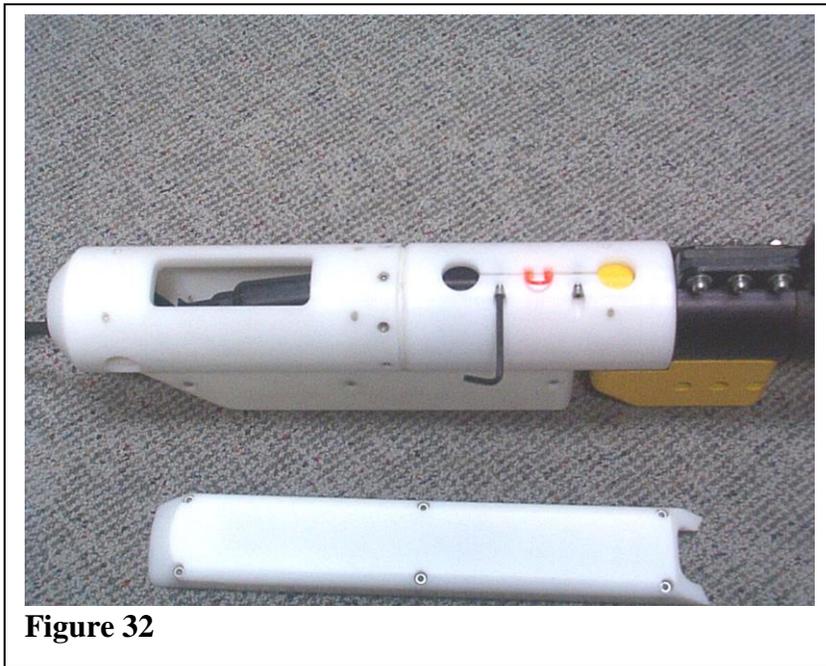
The G-882 is designed so that the sensor optical axis is perpendicular to direction of the tow. The sensor may be oriented at any angle from vertical to horizontal by rotating the main fish tube or "T" section.

The sensor head should be oriented so that the earth's field vector arrives at an angle of from 15° to 75° to the optical axis of the sensor. The earth's field vector is vertical at the poles, between 50° and 60° in the mid latitudes and horizontal at the magnetic equator. (See CSAZ program on Magnetometer CD). Adjusting the sensor for the polar and mid-latitude regions is simple, by orienting the sensor either at 45° (rotating the main tube 1/8th turn for polar regions) or 0° (no rotation required at mid-latitudes) respectively. The vast majority of surveys will be conducted using these two orientations.

The equatorial region is a special case. There is a band of approximately 500 miles wide in which the magnetometer can survey only in certain directions with a given sensor orientation. For instance, if the survey will be conducted in an east-west direction at the magnetic equator, simply rotating the sensor to the 45° position (same as for the polar region) will produce excellent data



5/32" HEX L-

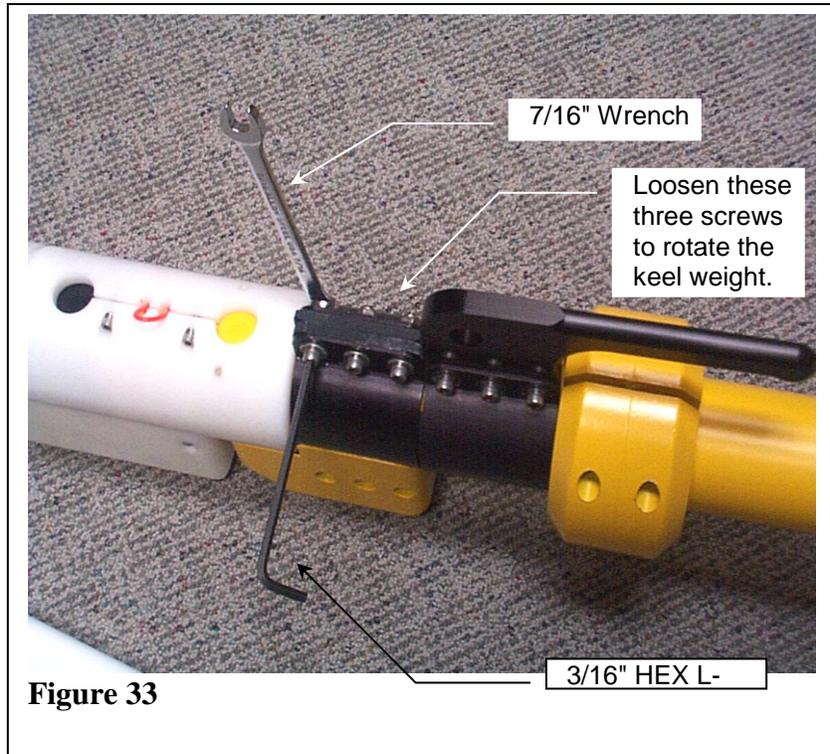


The Geometrics program "CSAZ" available on your CD or our website will give the user the optimal sensor angles for the area of interest. See the CSAZ manual (under help in the program) for further explanation of the use of CSAZ

Changing sensor orientation is simple. This adjustment will allow the sensor's optical axis roll angle to be set to any angle (typically only 0°, 45° or 90° required.)

This roll angle is set by the position of the keel weight on the tow fish body in relation to the "T" containing the sensor. To change this angle, loosen the three clamping screws at the top of the clamp and rotate the keel weight to the desired position and then tighten the clamping screws (Figure 33)

NOTE: In current design, the carrying handle attaches directly to the keel weight so that loosening the carrying handle will also loosen the keel weight allowing rotation of the weight and handle at one time.



If an echo-sounder Altimeter is employed, then you will need to rotate the nose of the fish also to keep the altimeter pointed towards the sea floor. Simply remove the nose top cover and loosen the clamping screws (Figure 32) and rotate the nose to line up the altimeter with the orientation weight. Retighten the nose clamp screws and you are done. (Note: Do not remove the orange trimmer string that attaches the nose to the fish body unless you are replacing the nosepiece).

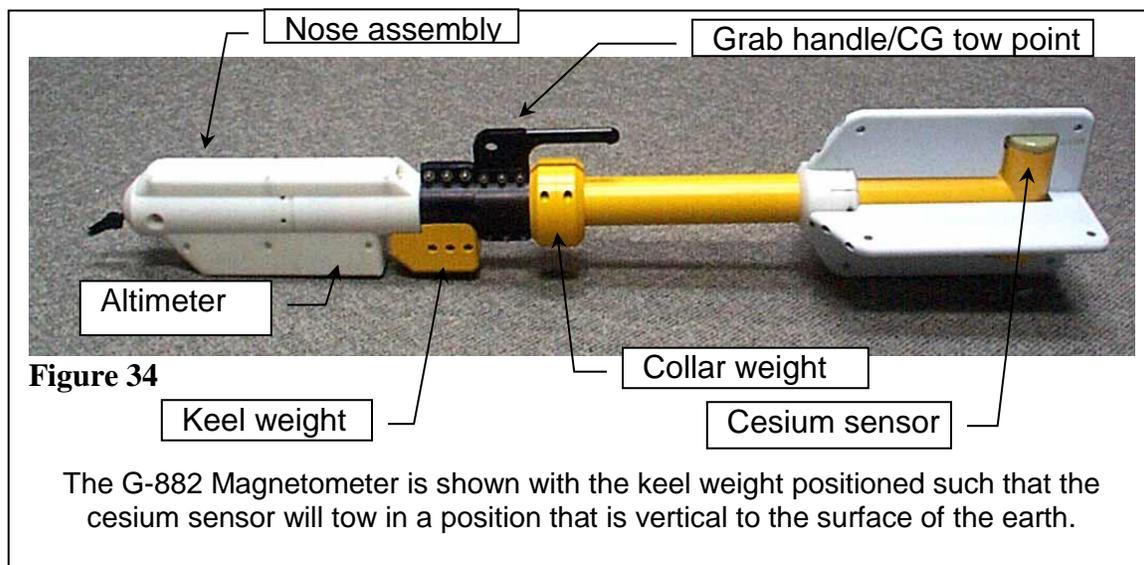
4.3.1 Sensor Positioning in Relation to the Dip Angle of the Survey Area

Optimal positioning the G-882 cesium sensor is necessary to insure that the best performance will be obtained for any given survey area. To accomplish this, we recommend that the sensor be oriented such that the Earth's magnetic field lines (H field) are centered in its active zone. We also want the orientation to provide nearly equal performance in all four towing directions (forward and reverse of two orthogonal towing directions for tie lines) to facilitate a methodical survey plan. To get information about sensor orientation we suggest you use the program CSAZ available from our website and on the Magnetometer CD for complete worldwide survey recommendations.

You can use the INCLINATION map (see figure 35) to estimate the proper orientation angle anywhere in the world as described below A TOTAL INTENSITY map is also provided to enable determination of the expected range of readings for the survey area (see figure 36).

Since the G-882 has “automatic hemisphere switching”, reversing direction is automatically handled and identical sensor positions are required for operation in the Northern or Southern hemispheres. Thus there are three regions in either hemisphere that are of interest with regards to positioning the G-882 cesium sensor. These regions have dip angles or magnetic field inclination angles of 0° - 22.5° , 22.5° - 67.5° and 67.5° - 90° in either hemisphere.

Assembling the G-882 as pictured below (vertical sensor) provides the best operation in the 22.5° - 67.5° region. Note that in this picture the orientation weight and CG tow point are attached to the tow fish such that the cesium sensor will be maintained in a position vertical to the Earth’s surface while under either nose tow or CG tow.



If an altimeter is present, the nose assembly must also be adjusted so that the altimeter is also directed towards the seabed. See previous section on adjustment procedures.

For the 67.5° - 90° inclination angle regions, roll the sensor to an angle of 45° with respect to the Earth’s surface.

For the 0° - 22.5° inclination angle regions, roll the sensor 90° until it is horizontal with respect to the Earth’s surface. CSAZ has more information on fine tuning this orientation in equatorial regions.

Roll angles other than 0° , 45° , and 90° tend to produce signal to noise ratio patterns that are asymmetrical. This could cause unequal instrument

performance in the reverse and orthogonal directions of a typical survey. See CSAZ program.

4.3.2 Main Field Inclination and Total Intensity Maps

The maps on the following two pages may be used to determine the inclination and total intensity of the Earth's magnetic field in the survey area. The inclination information may be used to properly adjust the sensor position for the best performance in the intended area of survey. The intensity information may be used as a check of the system operation, i.e., that the readings appear to be in the range that is expected for the survey area. This information is also included in the CSAZ program.

US/UK World Magnetic Model - Epoch 2020.0

Main Field Inclination (I)

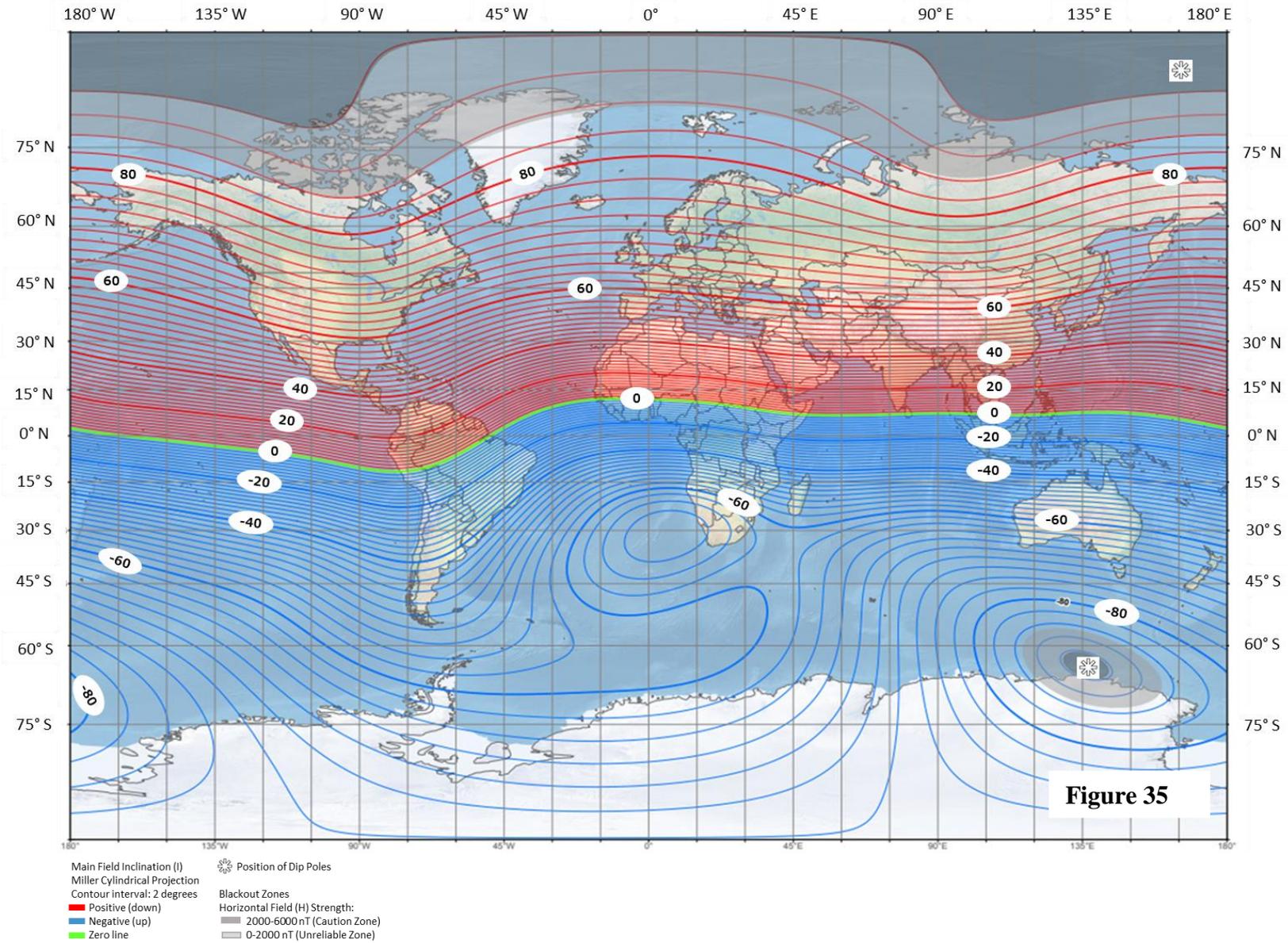
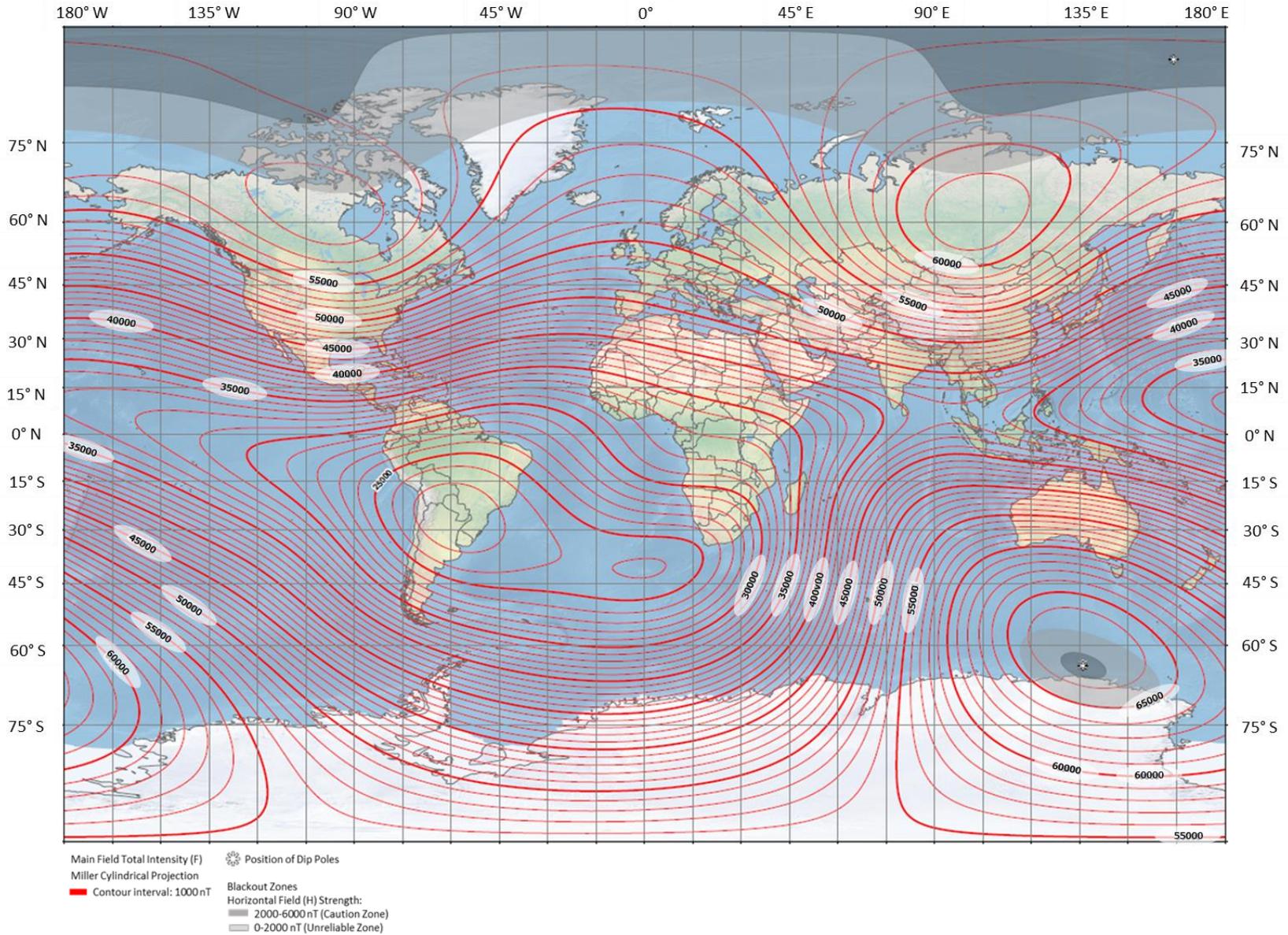


Figure 36

US/UK World Magnetic Model - Epoch 2020.0 Main Field Total Intensity (F)



4.4 CM-221 Counter Data Format and Command Structure

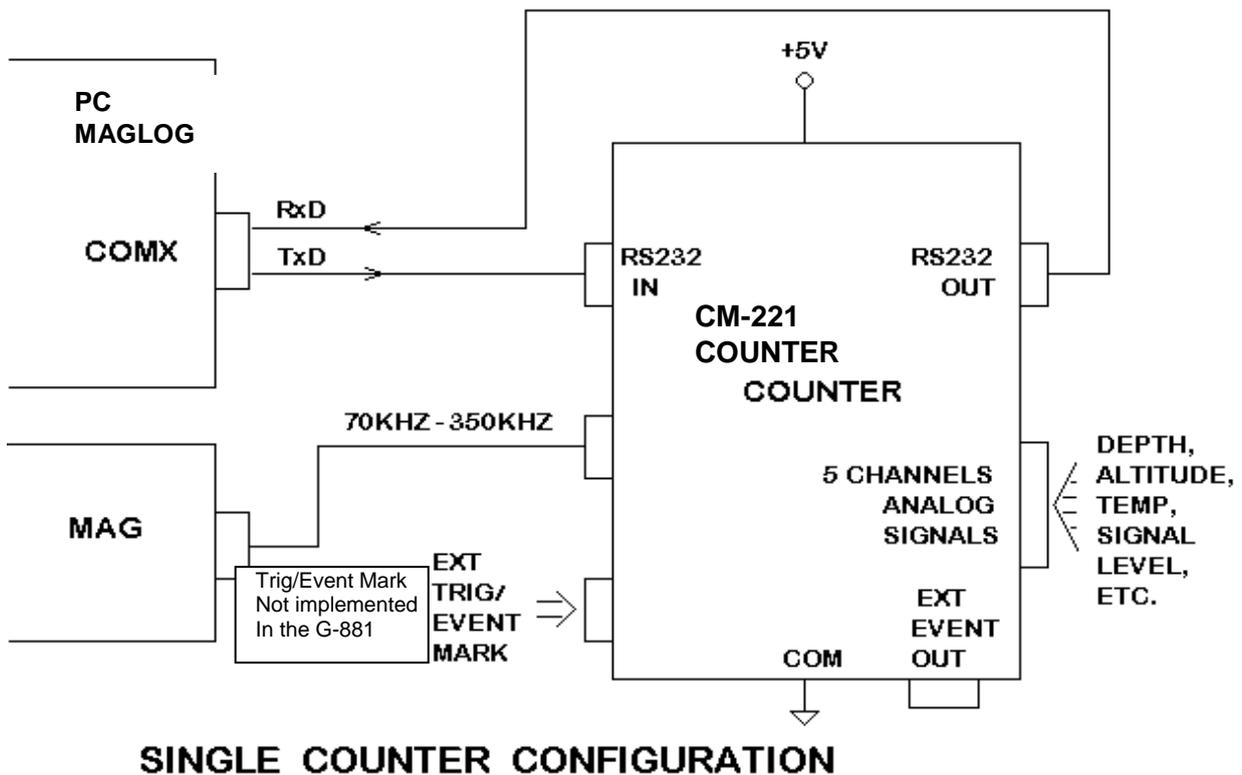
The CM-221 counter module is a counting device that converts the cesium Larmor signal (70 kHz to 350 kHz) into magnetic field strength in nanoteslas (20,000 nT to 100,000 nT). In addition there are 5 external 12 bit A/D channels and 1 internal A/D channel that can be digitized and appended to the output data. A Julian clock string can be enabled and added to the output data stream as well. Finally there is an External Event pin that can be used for external trigger or event marking.

The output data format is programmable. For example each of the A/D channels can be added/removed from the output data stream by sending the appropriate commands. There are several other commands that are discussed in detail later in this document.

4.4.1 Output Format

Figure 37 shows the standard single counter configuration. Commands from the PC are sent out the RS232 transmit pin (TxD) to the counter. Mag and other data return on the receive pin (RxD).

Figure 37



Upon power on the counter module defaults to its last saved setup as defined by the user using the UPDATE function described later.

Baud rate: 9600 baud, 8 data bits, no parity, 1 stop bit

Cycle rate: 10 Hertz

Analog channels: Channel 0 (Larmor signal level) enabled, depth and altitude channels, when applicable, enabled, and channels 3-8 disabled.

Julian Clock: Disabled

Output Format: ASCII

The default output data stream contains all printable ASCII characters with each sample terminated with a carriage return/ line feed sequence. The following example illustrates this format where there are no depth or altitude analog channels enabled:

char # description

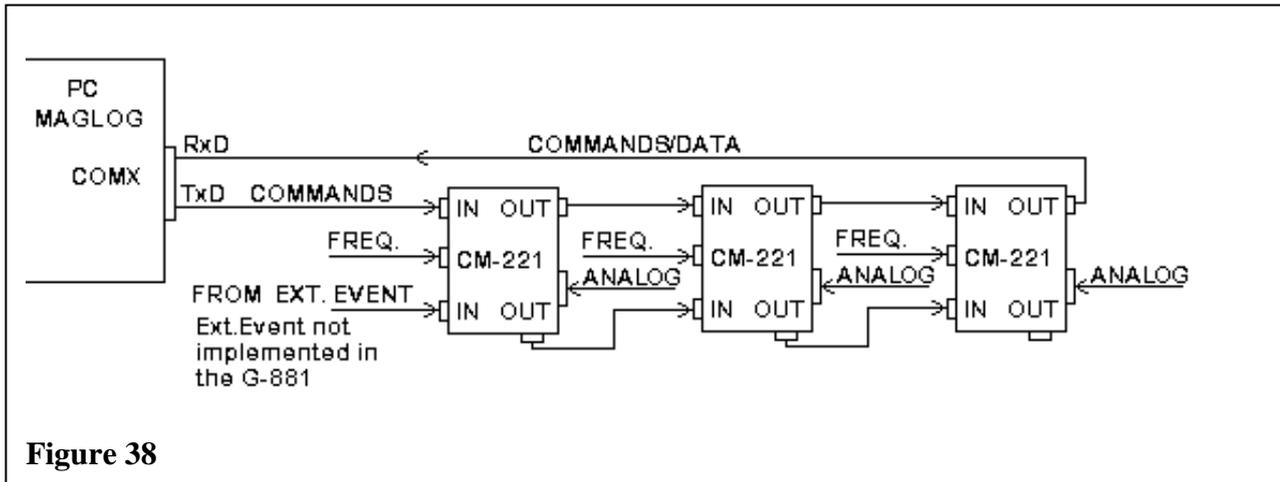
- 1 An ASCII '\$' (marks first character of data stream)
- 2 an ASCII '1' or a blank (depending on whether Mag reading is above or below _99999.999 nT).
- 3-7 5 digits of Mag data
- 8 an ASCII decimal point ['.']
- 9-11 3 more digits of Mag data
- 12 an ASCII comma [',']
- 13-16 4 digits of A/D channel 0 (9999 full scale, 0 to +5 volts in). This channel is internal and contains the signal level of the magnetometer.
- 17 an ASCII carriage return
- 18 an ASCII line feed

If the data were captured to a file and then copied to a line printer the printout would look something like this:

```
$ 49895.131,1249  
$ 49895.376,1287  
$ 49995.517,1245  
$ 49995.293,1272  
$ 49995.835,1229  
$ 49995.071,1281  
$ 49995.159,1298  
$ 49995.508,1214  
$ 49995.216,1245  
$ 49995.347,1297
```

Counter modules can be daisy chained to form multiple sensor arrays as shown in Figure 38. Note that the output data from counter 0 goes into the input port of counter 1, and so on. This allows each counter module to append its output data onto the end of the data stream coming from the previous counter(s). As each counter receives data characters from previous counters they get echoed to the next. An exception to this is the carriage return/ line feed sequence. The carriage return is replaced by a comma and the line feed is ignored. Thus one long concatenated string from all counters is output from/through the last counter, and is terminated by a carriage return/ line feed sequence by the last counter only.

Note that only the first counter outputs a preamble character (the default character is '\$').



MULTI-COUNTER MODULE CONFIGURATION

4.4.2 General Command instructions

Commands are sent into the input port of the first counter. Note that commands are the only characters that enter the first counter. A command string is stored in an incoming buffer until terminated by a carriage return. The command will then be executed at the end of the current sample, immediately after the last 'data' byte has been sent out the output port. Then the command will be echoed to the next counter (or back to the logging computer if it is the last/only counter in the chain).

Subsequent counter modules in multiple counter arrays differentiate between output data and commands by assuming that all characters between the data preamble character ('\$' is the default) and the next line feed are Data bytes from the previous counter(s). Commands only arrive at subsequent counters after the data transmission is complete. Each command is identified by the first character, followed by some number of operand characters and a carriage return.

Only one command can be sent at a time. After each command, wait for the command echo before sending another.

All commands are terminated with a carriage return. A line feed may be sent as well, but it will be ignored by each counter module. However, at the end of every output data string there will be a carriage return and a line feed sent. This method insures that the final counter will have a carriage return/line feed sequence so that if the file is printed it will look correct on paper. By using the carriage return as the command terminator and stripping input line feeds insures that dumb terminals (and dumb terminal emulation software) can be used to control the counter output. (Dumb terminals do not normally transmit line feeds when <Enter> is pressed).

4.4.3 G-882 Quick Command list

This is a list of commonly used commands for the G-882 magnetometer. For a full list of commands and command options refer to the commands section of the manual (below).

Set Cycle time

C0100 <enter> sets the magnetometer to sample at 1 second intervals.

C0010 <enter> sets the magnetometer to sample at 0.1 second intervals.

Set A/D channels on/off for a single magnetometer (see full list for control of more than one magnetometer) '0' = turn off channel; '1' = turn on channel.

The G-882 has a total of 8 analog channels (0-7) plus magnetic field reading.

A11 turns on channel 1

A12 turns on channel 2

A13 turns on channel 3 (up to 8 analog channels)

A01 turns off channel 1

A02 turns off channel 2

A03 turns off channel 3 (up to 8 analog channels)

In a typical system they are designated as follows:

Magnetic field (always on)

Chan. 0 Signal

Chan. 1 Depth

Chan. 2 Altimeter

Chan. 3 Brightness indicator

Chan. 4 RF Effort indicator

Chan. 5 Heater Effort indicator

Chan. 6 +28 Volts at magnetometer

Chan. 7 +21 Volts at magnetometer

Note: The Depth, Altimeter, Brightness, RF Effort, Heater Effort, +28 Volts, and +21 volts need to have calibration coefficients applied to convert to feet, meters, or volts.

4.4.4 G-882 Detailed Commands

Here are the current list of commands and the format of each:

Command	Format:	Description:
Set Cycle time	Byte 1: 'C' 2: x 3: x 4: x 5: x x: x 6/7: CR	Set time in 0.01 sec increments MS digit of number ('0'-'9') 3S digit of number 2S digit of number LS digit of number 5 MS optional char ('0' or '5') carriage return

[Note: the 5 MS char is optional. It was added to allow setting the cycle time to more precision after the initial software release]

Set A/D ch's	Byte 1: 'A' 2: x 3: x 4: x 5: x 6: CR	Enable/disable A/D channels '0' = turn off channel; '1' = turn on select channel #('0'-'7')('0'-'7' for CM-221) MS digit of counter # ('0' or '1') LS digit of counter # ('0' - '9') carriage return
--------------	--	---

[Note: characters 4 and 5 can be omitted. If this is done the command will default to counter 0.]

Change Baud Rate	Byte 1: 'B' 2: x 3: x 4: x 5: x 6: x 7: CR	Baud rate change command MS char (1,0,0,0,0,0,0) S char (9,9,4,2,1,0,0) 3S char (2,6,8,4,2,6,3) 2S char (0,0,0,0,0,0,0) LS char (0,0,0,0,0,0,0) carriage return
------------------	--	---

Command	Format:	Description:
Output Format	Byte 1: 'O' 2: x x: x 3: CR	select output format format select: 'A'= ASCII (default) 'E'= excess 3 'P'= packed BCD 'S'= Sandia G822A fmt '0' = Sandia single Mag '1' = Sandia dual Mag carriage return

[Note: the '0' and '1' 3rd characters are valid only when selecting the Sandia format]

Julian Clock Format:	Byte 1: 'O' 2: J 3: x 4: x 5: x 6: x 7: x 8: x 9: x 10: CR	select output format format select: Day field: '1'= on ; '0' = off Hour field: '1'= on ; '0' = off Min field: '1'= on ; '0' = off Sec field: '1'= on ; '0' = off 10mS field: '1'= on ; '0' = off MSB of counter # ('0' or '1') LSB of counter # ('0' thru '9') carriage return
----------------------	---	---

[Note: characters 8 and 9 can be omitted. If this is done the command will default to counter 0.]

Julian Time Enable:	Byte 1: 'J' 2: x 3: x 4: x 5: CR	Enable/Disable Julian time output '0' = turn off; '1' = turn on MS digit of which counter ('0','1') LS digit of counter # ('0' - '9') carriage return
---------------------	--	---

[Note: characters 3 and 4 can be omitted. If this is done the command will affect all counters in the chain.]

Set Julian Day:	Byte 1: 'D' 2: x 3: x 4: x 5: CR	Set the Julian day number MS digit of number ('0'-'3') 2S digit of number ('0'-'9') LS digit of number ('0'-'9') carriage return
-----------------	--	--

Command	Format:	Description:
-----	-----	-----
Set Hour:	Byte 1: 'H' 2: x 3: x 4: CR	Set the hour MS digit of number ('0'-'2') LS digit of number ('0'-'9') carriage return
Set Minute:	Byte 1: 'M' 2: x 3: x 4: CR	Set the minute MS digit of number ('0'-'5') LS digit of number ('0'-'9') carriage return
Set Second:	Byte 1: 'S' 2: x 3: x 4: CR	Set the second MS digit of number ('0'-'5') LS digit of number ('0'-'9') carriage return
Find counters:	Byte 1: 'F' 2: '0' 3: '0' 4: CR	Find and assign counter numbers assign first counter as # 0 (MSB) LSB carriage return
Set Preamble	Byte 1: 'P' 2: x 3: CR	Set the preamble char ('\$') The desired character carriage return
Jump to debug	Byte 1: 'X' 2: 'B' 3: 'U' 4: 'G' 5: CR	first char of 'XBUG' string 2'cnd char 3'rd char 4'rth char carriage return

Command	Format:	Description:
Error echo	Byte 1: 'E' 2: 'R' 3: 'R' 4: x 5: x 6: ':'	Syntax err - echo 'ERR' + counter # 2'cnd char 3'rd char MS digit of counter number ('0'-'1') LS digit of counter number ('0'-'9') colon delimits error message cmd

[Note: xxx: bad command string is echoed in the following characters, followed by a ...
x: CR carriage return]

Reset	Byte 1: 'R' 2: 'E' 3: 'S' 4: 'E' 5: 'T' 6: CR	Reset the microprocessor 2'cnd char 3'rd char 4'th char 5'th char carriage return
Interrogate Setup:	Byte 1: 'I' 2: x 3: x 4: x 5: CR	Interrogate command item select: 'A'= Analog output fields selected 'J'= Julian Clock fields selected 'V'= software version number. MS digit of counter number ('0'-'1') LS digit of counter number ('0'-'9') carriage return

[Note: Characters 3 and 4 are optional. If they are omitted the command will return the output from counter 0.

4.4.5 Update Default Parameters

Your magnetometer has been supplied with a default parameter update function. This means that you may change the operational parameters (baud rate, cycle time, number of analog channels turned on) and then save that configuration in the processor non-volatile memory so that the next time the magnetometer is started, these parameters are loaded. Once the configuration is set by the user, and the user determines he or she would like to save this configuration, the UPDATE command is sent by the MagLog-Lite or MagLog-PRO program via the CM201CFG.EXE program. The CM201CFG is placed on the computer desktop when the MagLog-Lite or MagLog-PRO program is installed and is available to check or change the magnetometer configuration and store the values in non-volatile memory. Clicking on the STORE CONFIGURATION (lower left button) sends the proper commands to the magnetometer counter board(s).

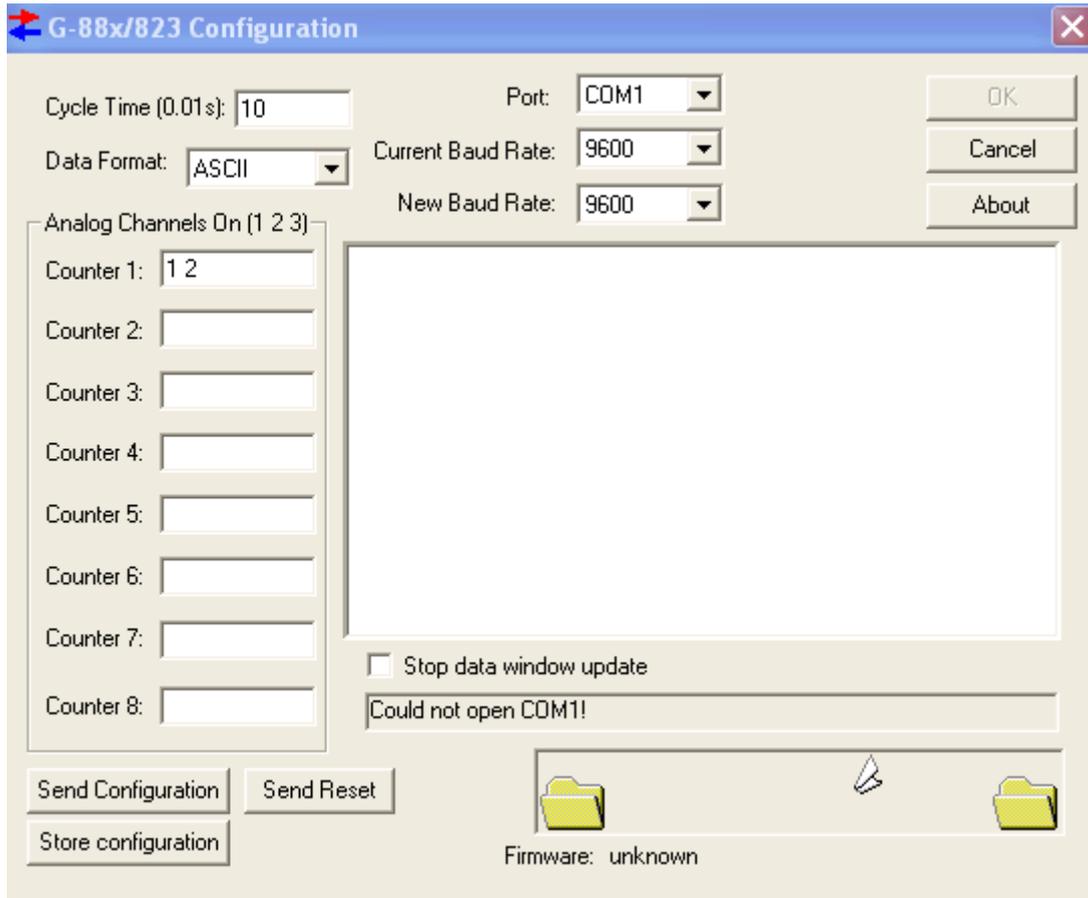


Figure 39

Alternately the user may store the configuration manually using a terminal emulator such as HyperTerminal by entering the following commands:

Update	Byte	1: 'U'	Update operation parameters
		2: 'P'	2 nd character
		3: 'D'	3 rd character
		4: 'A'	4 th character
		5: 'T'	5 th character
		6: 'E'	6 th character
		7: CR	carriage return

[Note: If it is desired to permanently save any changes to the operation parameters that may have been made, sending an UPDATE command before powering down will save them. The next time the system is powered-on the new, saved parameters will be used.]

The addressed counter will insert characters into the command string just before the carriage return before echoing to subsequent counters. See detailed command description for format and definition of these added characters.

4.4.6 Command Set Descriptions

Cycle Time Set:

Cycle time is set by transmitting the number of 0.01 second increments needed to make the desired output rate. The default rate is 10 hertz (C0010). To set the output rate to 1.2 seconds the command string would be "C0120".

After the initial software release another character was added to allow the cycle time to be set to 5 ms resolution. To maintain compatibility with older versions this character is optional. For an example on using this extra precision, the command "C00125" would set the cycle time to 8 hertz (125 ms).

A/D channel select/enable:

Three pieces of info are needed to select and turn on/off an A/D channel: The counter #, the channel number, and a flag indicating whether to enable or disable that channel. The enable/disable flag is sent first (after the 'A' command identifier). A '0' character will turn off the channel, a '1' turns it on. The next character specifies the channel number (0-5 for CM-201 or 0-7 for CM-221), followed by 2 characters indicating the counter number (00-19). If the counter number is not sent then it defaults to counter 0.

Baud Rate Change:

The baud rate can be commanded to change by giving a 'B' command character followed by 5 more number characters specifying the desired baud rate. Valid baud rate commands are: 'B19200', 'B09600', 'B04800', 'B02400', 'B01200', 'B00600', and 'B00300'. This command will not execute until the entire command has finished echoing out to the next counter/logging device. This allows the command to propagate through all counters and be implemented before output data arrives at a different rate.

Output Format Select:

The default (ASCII) output format is described in detail at the beginning of this document. This is the easiest format to view and import into various processing utilities. It is also very inefficient in terms of disk storage space and time required to transmit each cycle. There are three other output formats that can be used as well:

Packed BCD:

Packed BCD format throws away all commas, decimals, spaces, and the magnetometer most significant byte ('1' if more than 100,000 nT, or a blank is less than 100,000nT). The Preamble character is left alone. In addition all numeral characters (ASCII codes 30 hex through 39 hex) have the upper nibble (always a 3) discarded and two lower nibbles combined to form one byte. Finally, the carriage return, line feed sequence is replaced with a single terminating character '*' (2A hex).

It is very difficult to show what these files would look like if displayed on a computer screen since each type of computer would display these binary characters differently. Many of these binary characters would be interpreted as screen commands which might ring the bell or clear the

programs can be configured to handle these characters as data instead of commands, but this is not the way the typical default configuration is set up.

Packed BCD eliminates this by shifting all numbers up by 33 hex. This moves all possible output values out of the control character range. It also makes them printable to a screen or printer without bells, beeps, screen clears, form feeds, etc. However they will still look like gibberish without translation.

Sandia/G822A format:

This is a printable ASCII format that mimics the output from a one or two channel G822A magnetometer. Its output is limited to one counter module, with the Mag and signal level values as the only data being sent out. The Mag reading is preceded with an 'A' followed by 10 characters of ASCII Mag data. The G822A format sometimes has a second Mag reading following the first which is preceded with an ASCII 'B'. If selected the CM-221 counter places the signal level in the first 4 significant characters of the second Mag data slot. The sample is terminated by a carriage return line feed sequence.

The purpose of this format is to allow customer with existing G822A Sandia logging software to be able to use the CM-221 without upgrading to new logging software.

The single channel Sandia format is selected with the command string "OS" or "OS0". The dual channel output is selected by the command string "OS1".

Example outputs:

This is the ASCII output example from earlier, but with 3 A/D channels:

```
-----  
$ 49895.131,1249,0004,0005  
$ 49895.376,1287,0003,0007  
$ 49995.517,1245,0003,0006  
$ 49995.293,1272,0005,0006  
$ 49995.835,1229,0004,0005  
$ 49995.071,1281, 0006,0006  
$ 49995.159,1298, 0003,0007  
$ 49995.508,1214,0004,0007  
$ 49995.216,1245,0004,0004  
$ 49995.347,1297,0003,0005
```

Similar data displayed in hexadecimal:

```
-----  
  
24 20 39 39 37 37 38 2E 31 33 31 2C 33 37 34 39  
2C 30 30 30 34 2C 30 30 30 35 0D 0A 24 20 39 39  
38 39 30 2E 33 37 36 2C 33 36 38 37 2C 30 30 30  
33 2C 30 30 30 37 0D 0A 24 20 39 39 39 35 35 2E  
35 31 37 2C 33 35 34 35 2C 30 30 30 33 2C 30 30  
30 36 0D 0A 24 20 39 39 39 39 38 2E 32 39 33 2C  
33 34 37 32 2C 30 30 30 35 2C 30 30 30 36 0D 0A
```

24 31 30 30 30 37 38 2E 38 33 35 2C 33 33 32 39
2C 30 30 30 34 2C 30 30 30 35 0D 0A 24 31 30 30
30 33 32 2E 30 37 31 2C 33 33 38 31 2C 30 30 30
36 2C 30 30 30 36 0D 0A 24 20 39 39 39 37 39 2E
31 35 39 2C 33 34 39 38 2C 30 30 30 33 2C 30 30
30 37 0D 0A 24 20 38 36 37 37 38 2E 35 30 38 2C
33 35 31 34 2C 30 30 30 34 2C 30 30 30 37 0D 0A
24 20 37 38 37 37 38 2E 32 31 36 2C 33 36 34 35
2C 30 30 30 34 2C 30 30 30 34 0D 0A 24 20 36 39
39 37 38 2E 33 34 37 2C 33 37 39 37 2C 30 30 30
33 2C 30 30 30 35 0D 0A

Similar data in Packed BCD format:

24 99 77 81 31 37 49 00 04 00 05 2A 24 99 89 03
76 36 87 00 03 00 07 2A 24 99 95 55 17 35 45 00
03 00 06 2A 24 99 99 82 93 34 72 00 05 00 06 2A
24 00 07 88 35 33 29 00 04 00 05 2A 24 00 03 20
71 33 81 00 06 00 06 2A 24 99 97 91 59 34 98 00
03 00 07 2A 24 86 77 85 08 35 14 00 04 00 07 2A
24 78 77 82 16 36 45 00 04 00 04 2A 24 69 97 83
47 37 97 00 03 00 05 2A

Similar data in Excess 3 format:

57 CC AA B4 64 6A 7C 33 37 33 38 5D 57 CC BC 36
A9 69 BA 33 36 33 3A 5D 57 CC C8 88 4A 68 78 33
36 33 39 5D 57 CC CC B5 C6 67 A5 33 38 33 39 5A
57 33 3A BB 68 66 5C 33 37 33 38 5D 57 33 36 53
A4 66 B4 33 39 33 39 5D 57 CC CA C4 8C 67 CB 33
36 33 3A 5D 57 B9 AA B8 3B 68 47 33 37 33 3A 5A
57 AB AA B5 49 69 78 33 37 33 37 5D 57 9C CA B6
7A 6A CA 33 36 33 38 5D

Similar data displayed in dual channel Sandia/G822A ASCII format:

A9977813100B3749000000
A9989037600B3687000000
A9995551700B3545000000
A9999829300B3472000000
A0007883500B3329000000 (Note how the most significant '1'
A0003207100B3381000000 is truncated for readings greater
A9997915900B3498000000 than 100,000 nT).
A8677850800B3514000000
A7877821600B3645000000
A6997834700B3797000000

The same data in single channel Sandia format (ASCII):

A9977813100
A9989037600
A9995551700
A9999829300
A0007883500
A0003207100
A9997915900
A8677850800
A7877821600
A6997834700

Julian Time Set:

The Set Time commands (D,H,M,S) will initialize the time in all counter modules. If a particular counter has all Julian clock fields enabled the output string will have the following inserted after the last A/D channel and before the CR/LF:

,DxxxHxxMxxSxx_xx

The x's would be ASCII characters (0-9) as required. The time registers are not incremented until enabled with the 'J1xx' command, so they can be set up then synchronized by sending the enable command at the correct time.

In Packed BCD and excess format the letters D,H,M,S, and _ are stripped and the data encoded as per the Mag data above. The Day info is put into 2 bytes with the most significant nibble of the most significant byte set to zero.

Julian Time Enable:

This command starts/stops the Julian clock. To start the clock on counter 0 the command would be "J100". "1" turns on the clock, while the "00" selects counter 0. To turn off the clock update on counter 2 the command would be "J002".

If the counter number information is omitted the command will affect all counter in the chain. Thus the command "J0" will turn off the update for every counter.

Note that the "Jxxx" command only affect whether the clock increments with time. It has no effect on whether or which clock fields are output. The "OJxxxxxy" commands selects which field are output.

Interrogate Setup command:

This command allows the operator or logging software to identify which analog channels and Julian clock fields are being output via the serial port. This information is used to verify output fields with their hardware channels, and to allow automated calculation of data field position within each sample being sent out. In addition the software revision number can be interrogated.

The first character 'I' designates the interrogate command, the second letter designates which item to interrogate. 'A' specifies interrogating the analog channels, 'J' specifies the Julian clock, and 'V' specifies the software revision number.

The next two characters specify the counter number '00' through '19'. If the counter number is omitted, counter 0 will respond.

The addressed counter will insert a response into the command string before sending echoing it out the serial port to the display terminal or subsequent counter modules. Subsequent counter modules will ignore these extra response characters and pass them unmodified down the chain. The response format for each of the three interrogate items are detailed in the examples below:

Analog channels:

The command "IA01" will command counter number one to output characters indicating which of the six analog channels have been selected for output. Counter 1 will modify the command string to "IA01:abcdef" where the letters a-f are either an ASCII '0' (channel off) or '1' (channel on) corresponding to channels 0-5 respectively. If analog channel 0,3, and 4 were selected on counter 1 the echoed command string would be "AI01:100110" followed with a carriage return line feed.

Julian Clock:

The command "IJ" will command counter 0 to output which Julian clock fields have been selected for output (note that the two digit counter number was not specified, so counter 0 responds by default). Counter 0 will modify the command string to "IJ:abcde" where the letters a-e would be replaced with an ASCII '0' (field off) or '1' (field on). The five output fields are:

- a: Julian day
- b: Hour
- c: Minute
- d: Second
- e: Fractional Seconds (to 10 milliseconds)

If counter 0 had all clock fields selected for output except the Julian Day it would modify the command string to "IJ:01111" followed with a carriage return line feed.

Software Version Number:

The command "IV02" will command counter 2 to send its two character software version number. Counter 2 would change the command string to "IV02:xx" where xx is the

version number of the software. If Counter 2 was software version "A4" then the echoed command string would be "IV02:A4" followed by a carriage return line feed.

Reset command:

If the command 'RESET' is sent to the counter a power up reset will occur initializing all parameters to default. The reset sequence will not start until the reset command has finished echoing out the RS232 port to the next counter/logging device. This allows each device down the chain to reset in sequence.

Update command:

If the command 'UPDATE' is sent to the counter, any parameters that were changed, will be saved and be the default parameters the next time the system is powered on. This command must be sent before powering down of the changes will be lost.

Jump to debug:

If the command string 'XBUG' is received the counter will do a one way jump to factory debug mode where a rudimentary operating system allows probing of registers, ports and memory for debugging purposes. It will only function properly with a single counter module (no daisy chained counters).

4.4.7 Power-up Initialization

By default all counters will wake up thinking that they are counter #0 and begin to output data at the default 10 hertz rate or as set by default parameters in flash memory. This data will appear as a synchronization command to subsequent counters and will cause a brief adjustment period until each counter determines where it stands in the daisy chain. Thus there will be a short period of garbled transmissions to the logging PC upon power-up or reset.

4.5 Accessory Software

4.5.1 Cesium Sensor Active Zones – CSAZ

A newly designed CSAZ Windows™ program is available on our Magnetometer CD and from our FTP site at <ftp://geom.geometrics.com/pub/mag/Software/> (look for csaz-setup.exe). Please read the manual that is included with the program for complete instructions on how to use the CSAZ program for worldwide inclination and sensor orientation solutions.

4.5.2 Slope – Intercept Method Depth Calibration

Here is a method for calculating the Scale Factor and Bias for depth calibration.

At the first depth, let the depth in meters be d1, and the raw reading r1.
At the second depth, let the depth in meters be d2, and the raw reading r2.

The formula for the Scale Factor is:

$$(d1-d2)/(r1-r2)$$

The formula for the Bias is:

$$(d_2 \times r_1 - d_1 \times r_2) / (r_1 - r_2)$$

You may also use Excel to calculate these values using linear regression. The advantage here is that you can use more than 2 depths and get a best fit for all the readings.

Put the actual depths in the first column. Put the raw readings in another column:

	A	B
1	True Depth	Raw Reading
2	1	30
3	5	34
4	30	46
5		
6	=INTERCEPT(A2:A4,B2:B4)	
7	=SLOPE(A2:A4,B2:B4)	

Use the INTERCEPT function to calculate the Bias. Use the SLOPE function to calculate the Scale Factor. Examples are shown in the table above. For this example, the Slope (Scale Factor) is 1.875, and the Intercept (Bias) is -56.75.

4.5.3 Depth Calibration Using MagLog-Lite™ or MagLog™

MagLog™ logging software from Geometrics provides capability to perform calibration of the depth sensor. It is performed very much like the methods described above. Refer to the excerpt from the MagLog-Lite™/ MagLog NT™ manual below.

Depth/Analog channel calibration

In order to get an accurate depth sensor reading, the pressure transducer sensor must be calibrated. This means that the depth sensor reading needs to be compared with a known depth to account for the variations occurring due to air pressure variations and to manufacturing variances. Bias and linearity adjustment can be made in the program to empirically calibrate for depth. (You can read more about this method at the end of the section).

The depth reading from the magnetometer is an integer between 0 and 9999. This represents the full-scale range of the depth transducer. There may also be a certain offset that must be adjusted.

MagLog™ offers a few ways of calibrating the depth.

Note: These methods also work for calibrating other analog channels

Calibration Procedure:

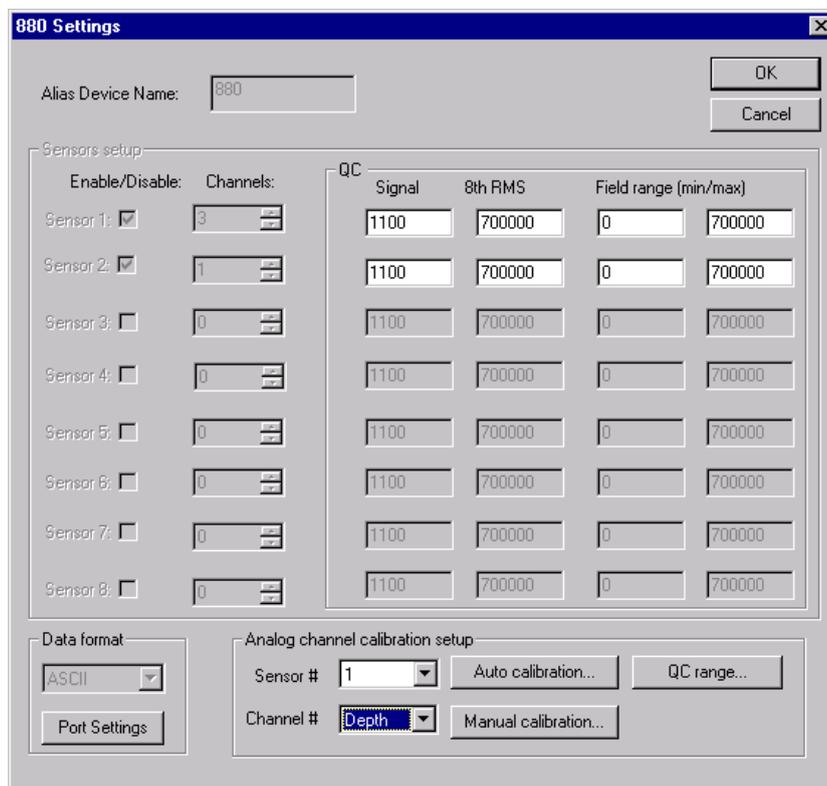
The basic procedure for calibrating the depth sensor is as follows:

- 1) Place magnetometer in the water for at least 15 minutes at a known depth, say 3 meters. This will give the temperature of the sensor time to stabilize.
- 2) Write down the depth and reading that MagLog™ gives you.
- 3) Place magnetometer in the water at a DIFFERENT depth.
- 4) Write down the depth and reading that MagLog™ gives you.
- 5) Use either automatic calibration feature or manual calibration to apply results.

Note: If you use automatic depth/analog channel calibration, you can do this while in the calibration screen.

Automatic Depth/Analog Channel Calibration:

- 1) From your configuration screen, you should select the magnetometer. This should bring up the “Settings” screen that you originally used to input the number of sensors and analog channels. (You can get to this screen by going into your main list of devices, and then double clicking on the magnetometer description). You should see a screen similar to the one below:



- 1) In the section labeled “Analog channel calibration setup” select the sensor and channel number that you want to calibrate, e.g., to calibrate the depth of the first sensor in the earlier example, select
Sensor #: 1
Channel #: Depth

- 2) Select “Auto calibration. You should then see the following dialog box:

Figure 40

Note: At this time depth data is coming from the fish that is being analyzed by the program to compute the bias and scale factor. You must place the fish on at least two depths to get an accurate calculation. During Altimeter Calibration discussed later, you must be over a hard bottom and the fish must be held horizontally level.

You can add measured points to this menu and have it automatically calculate your scale factor and bias. The depth sensor needs to be in the water for at least 15 minutes before you take your first measurement. This allows the temperature of the electronics to stabilize.

To add a new point, place fish at known depth. Press *Reset av.* to discard current average and wait for a few minutes to acquire a new one. Number after text *Current average:* should stabilize. Then enter the depth that the device is at under “*Value*” and press “*Add to the list*”. This will take the average measurement

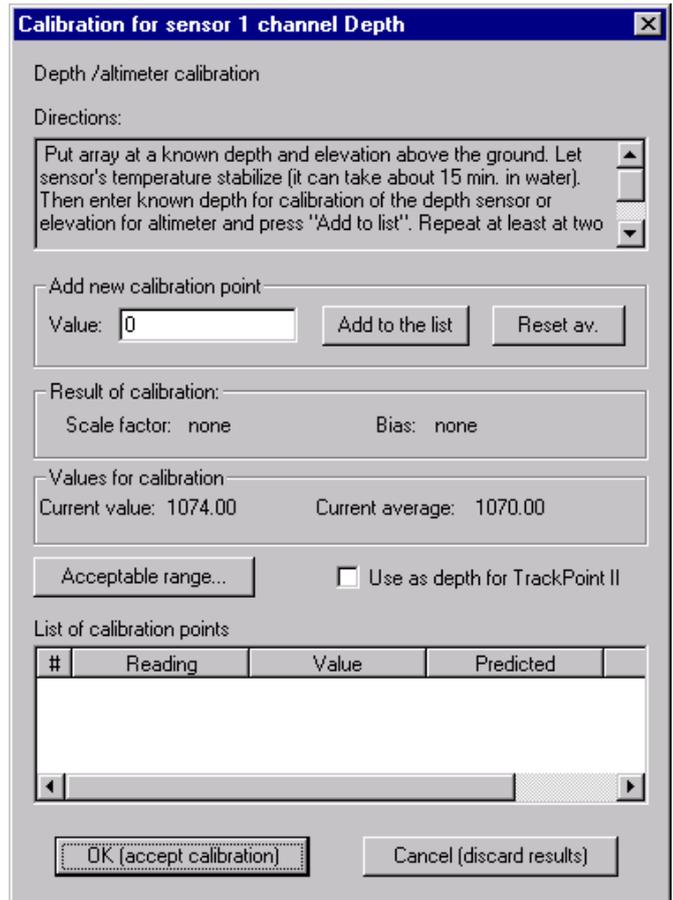


Figure 41

MagLog™ currently sees for the depth, and it will add it to a list of calibration points.

It is important to remember to reset the average if you move the sensor. You can do this by pressing “*Reset Av.*”.

You can also specify an acceptable range of points to be used by pressing “*Acceptable Range*”. This will bring up a dialog box that will allow you to set a minimum and maximum allowed value. This is particularly important when you calibrate your altimeter because occasionally you might get a spiked reading (missed echo) that you don’t want included in the calculation of your average.

After you have at least two points, MagLog™ will then try to calculate a scale factor and bias. You need to make sure that you have at least two different depth points (e.g. it is advised to have one point near the surface, and the second point as close to the bottom as possible). Otherwise, the calibrations will not be accurate. It is advised to add more than two points to get improved accuracy.

You should also select “*Channel Represents Depth*” from the dialog box in MagLog™. This option is important if you have an ORE Track Point II or other Sonar USBL tracking device and will be using the depth sensor to improve the tracking calculations.

If you are satisfied with the calibration, select “*OK*”.

You will then be given the opportunity to save your calibrations into a file. The file will keep track of the scale and bias calculated, and the readings used to make the calculation. It is advised to keep this for your records.

Manual Calibration

Manual calibration gives you the opportunity to enter the scale and bias directly without having MagLog™ calculate it for you.

You can find the scale and bias by hand, or use third party software.

To use the MagLog™ manual calibration feature, select “*Manual Calibration*” from your device settings menu. (Make sure that you have the correct sensor and channel selected as discussed in the section on “Auto Calibration”.)

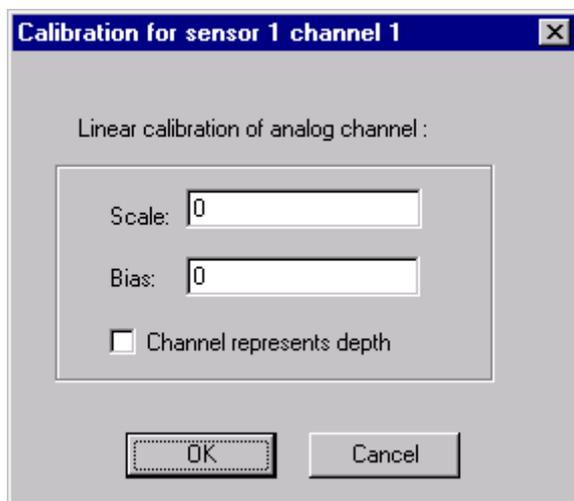


Figure 42

You will see a dialog box:

Enter your scale and bias values, and check “*Channel represents depth*” if this is a depth calibration. Then press “OK”.

You will be given the opportunity to save these into a file.

Effects of Depth Calibration

After you have calibrated your depth sensor, you should see immediate changes in your data. The graphs and displays will use the new calibrated values.

However, the device file will have the uncalibrated values (.880).

If you need to store calibrated values, you should use the Interpolator device that will write calculated depths and altitudes in the interpolator file.

Why Should We Calibrate?

This is a brief discussion on how MagLog™ calculates scale and bias values and why this is needed.

The depth sensor is a pressure transducer. This means that for a given pressure, it will output a number proportional to the pressure measured. However, the number is meaningless until we solve for a few factors.

Assume that the depth reading is related to the pressure reading by the following:

$$\text{Depth} = A \times \text{Pressure} + b$$

In this case, the two parameters A and b are the scale and bias values that we need to find.

We can solve for these two values if we have at least two sets of measurements. If we measure the following:

Depth	MagLog Reading (pressure)
Y1	X1
Y2	X2

I can then get two independent equations:

$$Y1 = A \times X1 + b \quad Y2 = A \times X2 + b$$

Solving for A and b, I get:

$$A = (Y1 - Y2) / (X1 - X2) \quad b = (Y2 \times X1 - Y1 \times X2) / (X1 - X2)$$

From here, we can now use these new values to calculate the correct depth, given only the pressure.

MagLog™ can then use these equations to automatically adjust all pressure readings to accurately reflect the depth measured.

4.6 Geomatrix G-882 digital Functions

The Geomatrix G-882 digital Board (GP120) is an add-on board for the Geometrics G-882 Marine Magnetometer, a G-882 with the board fitted is referred to as a G-882 digital.

The board adds several functions to the G-882 that have not previously been available.

The digital board is designed to be mounted inside any existing G-882 Magnetometer and enhances rather than replaces the existing CM221 counter board.

The following functions are provided by the board

- Provides Power to the Altimeter & allows direct access to the digital altimeter readings, previously only analogue readings were available
- Utilizes the existing G-882 Analogue depth sensor which, when plugged into the digital board give digital depth readings in Meters without user adjustment¹ & display depths correct for saltwater by default², fresh water is available via user selection. A fully digital 40Bar depth sensor is now also available
- Provides an on-board pitch & roll sensor, turned off by default²
- Adds optional Field markers to the output string, turned off by default²
- Allows user access to Hardware ID Information fields
 - GP120: Serial Number & Hardware Version
 - G-882: Serial Number, Manufacture Date & Sensor Serial Number
 - Altimeter: Manufacturer, Model, Serial Number, Range
 - Depth Sensor: Manufacturer, Model, Serial Number, Range
 - [Legacy Analogue Scale / Bias values] Not used by the digital board
- Allow user access to Maintenance Information
 - Most recent Repair History Log or Maintenance Note, up to 31 Characters per entry, 999 entries are possible

4.6.1 G-882 Digital User Modes

The digital board has 2 user modes, Standard Mode and Bypass Mode.

The board is factory configured to the G-882 is it installed in an in normal operation only Standard Mode should be needed. Bypass Mode is provided for the eventuality that a user may need to bypass the digital board for any reason.

The G-882 digital board responds to 4 types of commands in Standard Mode.

1. Mode Commands, start with “EG” are used to change between the operating modes, these are 5 digit commands and don’t support addressing.
2. Database Commands, start with “ED”. These commands are used to interrogate the digital boards’ database. These are all 5 digit commands and G-882 addressing is required.
3. Toggle Commands starting with “ET”. These are used to toggle between 2 different states e.g. “ON/ OFF”, the first command will turn on a function (if it OFF) and a second command will turn the same function OFF.

Three digit commands (i.e. those with no address) will operate on all units and give no user feedback other than the action taking place, the original command is sent unchanged to each Fish in turn & eventually back to the user.

5 digit (addressed) commands will operate on only the addressed unit & will respond with an acknowledgement.

G-882 addressing

¹ User can zero the reading the compensate for local variations

² User changeable setting, can be saved between uses if required



- Standard G-882 commands. Some standard G-882 commands are ignored or actively blocked by the G-882 digital board whereas others are simply passed through to the G-882's CM221 board.

G-882 digital MODE Commands

Command “EGBYP”⁴

Reboots the Digital board into Bypass mode, turns off the Digital functions & activates the data bypass switch so the system operates as a standard G-882.

NOTE: in this mode there is no interaction between the Digital board and the user, Commands are monitored and if possible acted on, e.g. “EGSTD” below, only Magnetometer functions are available, Digital board functions are NOT available including depth and altimeter readings

Command “EGSTD”

Reboots the Digital board into Standard G-882 digital mode, turns on the DIGITAL functions & deactivates the data bypass switch so the system operates as a G-882 digital unit.

When in Standard Operating Mode, the DIGITAL board adds accessory data strings into standard G-882 data strings.

When the DIGITAL Board is operating in Standard G-882 digital Mode, each of the data fields serial output string is fixed, with the option of turning the Field markers on or off.

All the strings are Digital, so no further calibration is required by the user to “post Process” this data.

The Output format is:-

Markers off	\$ 15507.890,0020,000.00,00.00,+001,+00,27
Markers on	\$ 15507.890,S0020,D000.00,A00.00,P+001,R+00,T27

\$Mag.field(nt),signal{,Depth(m),Altimeter(m),Pitch(±degrees),Roll(±degrees), Temperature}

NOTE: Values between braces { & } are optional & can be turned off

³ Note: If G-882's are concatenated in this way, any/all **non-digital** G-882's should precede the digital units. Reply messages can be truncated and G-882 addresses may not be accurate if this is not followed.

⁴ On receipt of these command the GP120 will store the mode then Reboot the board into the new mode. The new Mode will be retained until changed by the user i.e. the GP120 will BOOT into this Mode whenever Power is applied.

G-882 digital Database Commands⁵

Command “EDAxx”

Display Altimeter details e.g. Tritech PA200,4831.142949

Command “EDDxx”

Display Depth sensor details e.g. Druck 55-882-251,10563520

Command “EDFxx”

Fresh water calibration details for Depth sensor (legacy NOT used by the Digital board)

e.g. Fresh:S0.123456,B-3.41

Command “EDGxx”

Fish (G-882) details e.g. G-882,882999,2000_06_30,C9999

Command “EDIxx”

Digital Board details e.g. Geomatrix,GP120-4000,HW:4.00

Command “EDLxx”

Calibration details for Altimeter (legacy NOT used by the Digital)

e.g. Alt:S0.002840;B1.16

Command “EDRxx”

Repair History Display, will show the most recent History of the unit e.g.

or `egr00:000;No repair History`

`egr00:005;R0123:2016_10_07,R11785,GEOMATRIX`

Format is Command [edr][G-882 address][Entry #][max 31 chars of data]

Command “EDSxx”

Salt water calibration details for Depth sensor (legacy NOT used by the Digital board)

e.g. Salt:S0.123456,B-3.41

Command “EDVxx”

Firmware Version of Geomatrix Digital Board e.g. edv00:V01.03

⁵ Commands are all 5 digits. G-882 Number is compulsory for Database commands

G-882 digital Toggle Commands⁶

These commands can be used to toggle individual fields on or off, field order is shown below.

\$Mag.field(nt),signal{,Depth(m),Altimeter(m),Pitch(±degrees),Roll(±degrees),Temperature}

NOTE: Values between { & } are optional & can be turned off.

The relative positions of fields are always the same as shown above i.e. Temperature is always last, depth is always 3rd, if it is turned on. Depth will always precede the Altimeter which will always precede Temperature.

Command “ETA”

Toggle the ALTIMETER ON / OFF.

This command turns off the data field and the power to the Altimeter.

Command “ETD”

Toggle the DEPTH field ON / OFF.

This command turns off the data field and the power to the Depth Sensor.

Command “ETI”

Toggle between Imperial & Metric results in the Altimeter, Depth & Temperature fields.

Metric	Markers on	\$ 17479.521,S0020,D088.50,A29.70,P+001,R+00,T41
Metric	Markers off	\$ 17479.521,0020,088.50,29.70,+001,+00,41
Imperial	Markers off	\$ 17479.521,0020,0288,0327.2,+001,+00,105
Imperial	Markers on	\$ 17479.521,S0020,D0288,a0327.2,P+001,R+00,t105

NOTE: If markers are on when the “ETI” command is given, the case of the “A” (altimeter, xx.xx meters) marker will change to “a” (yyy.y feet) and the “T” (temperature xx C°) will change to “t” (yyy F°). The case of the depth sensor’s marker D, however, will remain unchanged as this indicates Water Type, see the “ETW” command. The number of digits displayed for feet is always 4 with 1 decimal place due to the maximum values involved and to attain a similar resolution.

NOTE: The “ETI” command only Toggles between Metric & Imperial values.

The “ETJ” command (see below) allows the Depth & Altimeter strings to be displayed in 2 different ways. The values shown above are with “ETJ” toggled off.

⁶ Toggle Commands: 3 digit commands will apply to all fish in a string so the unchanged command is sent through all Fish in series. 5 Digit commands (including the address) will apply to a specific fish only and in this case a status reply is sent

Command “ETJ”

Toggles how the Depth & Altimeter strings are formatted.

Used in conjunction with the “ETI” command to allow readings to be formatted in different ways.

If “ETJ” is ON

- string lengths for Depth & Altimeter is fixed at 4 characters with no decimal points
- no negative signs are permitted for Depth, negative values will be displayed as “0000”

Table 1 ETI/ETJ Truth Table⁷

ETJ 0=off 1=on	ETI 0=off 1=on	Result	Depth Format	Depth values	Altimeter Format	Alt Values
0	0	Meters	-###.## ###.##	-99.99 999.99	##.##	00.00 99.99
0	1	Feet	-####.# ####.#	-999.9 9999.9	####.#	000.0 999.9
1	0	Decimeters	####	0000 9999	####	0000 9999
1	1	Feet	####	0000 9999	####	0000 9999

Truth Table of possible formatting options using the ETI/ETJ commands⁸

Command “ETM”

Toggle Field Markers ON / OFF to identify a particular field.

Command “ETP”

Toggle the Pitch & Roll fields ON / OFF

Command “ETT”

Toggle the Temperature field ON / OFF. See also the “ETI” command.

⁷ V1.03 added an extra decimal point to the standard depth and Altimeter values

⁸ Values shown do not represent actual values possible, just the range of value the string can represent

Command “ETW”

Toggles Water Type between Fresh Water & Saltwater (used for Depth Sensor calculations). NOTE: If markers are on when the “ETW” command is given, the case of the “D” (depth) marker changes. “D” for Salt / “d” for fresh water.

```
etW:Depth Sensor Calibrated for Salt Water
$ 15507.890,S0020,D000.00,A00.00,P+001,R+00,T37
etW:Depth Sensor Calibrated for Fresh Water
$ 15507.890,S0020,d000.00,A00.00,P+001,R+00,T37
```

Command “ETZ”

Toggle Depth Zero correction ON / OFF.

The Depth Zero command, can be used to Zero the Depth reading of the G-882/s at sea level to ensure local variations don't affect the accuracy of the Depth reading:-

“ETZ” toggles the Depth Zero offset correction ON. The displayed depth value will be corrected to “000.0”, the value of the correction will be retained and applied to all subsequent depth readings, until powered down or reset.

A subsequent “ETZ” will toggles the Depth Zero offset correction OFF, the raw depth value will be displayed after that time.

NOTE: The depth Zero correction factor, will not be retained after a power down or reset unless the command is stored by issuing an “UPDATE” command.

If an update command is used to store the Depth Zero offset correction value, all future depth readings be altered by this same correction factor until a subsequent “ETZ” command is received & stored. The Boot prompt message will have a line reminding the user of the current depth Zero correction with one of 2 messages “Depth Offset is Zero” or “NON-ZERO DEPTH OFFSET STORED: xx decimeters”.

G-882 (CM221) Commands⁹

The Digital board also responds to these G-882 (CM221) commands

Command “BAUD”

Sets Digital board & G-882 baud rates, only 9600 & 19200 are recommended due to string lengths but all G-882 baud rates are supported in Standard mode.

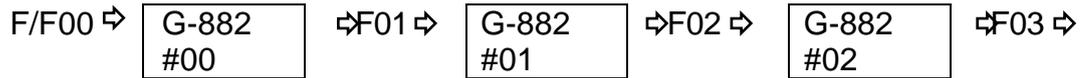
e.g. 9600 baud = B09600; 19200 baud =B19200;

Command “F” / “F00”

Find Counters command, this command is simply passed through to the G-882 digital board to the CM221 board. The reply is then sent to the next fish in line.

An “F” or “F00” sent to the first Fish in series will be incremented by each fish as it passes through, this gives a count of total Fish in series. i.e. F03 means 3 fish.

⁹ These commands are in the same format as those for a Standard G-882 without the G-882 digital board fitted.



Command “IA00”; “IV00”

These Interrogate commands, are simply passed through the through to the G-882 digital board to the G-881 board. The reply is then sent to the next fish in line.

IA00 □ IA00:10000000 should be “10000000” for G-882 digital
 Mode IV00 □ IV00:B9 Firmware version of CM221
 board

Command “RESET”

Resets the Digital & G-882 boards. Any changes, not previously saved with the “UPDATE” command will be lost on reset.

Command “UPDATE”

Saves changes to the G-882 & the Digital board.

The following settings will be saved by the Digital board when the UPDATE command is issued, (if they have changed since the board was last booted).

<ul style="list-style-type: none"> • Altimeter field ON / OFF • Depth field ON / OFF • Markers ON / OFF • Pitch & roll Fields ON / OFF • Temperature field ON / OFF 	<ul style="list-style-type: none"> • Water Type Salt / Fresh • Units (Imperial / Metric) Status • Units (var/fixed) status • Depth Zero correction • BAUD rate
--	---

G-882 digital Bypass MODE

[Command: EGBYP] from Standard operating mode.

In Bypass Mode the Digital Board is electrically bypassed and all Standard G-882 commands will operate as normal.

WARNING:

In Bypass Mode the Digital board cannot communicate with the user.

The Receive code for the “Tow Cable ” & “CM221 Communications in “Bypass Mode” is the same as used in Standard Mode, the exception being replies from the Digital board are inhibited in this mode since all data through the board in either direction is allowed to freely pass. In effect this means communications to & from the CM221 are monitored for commands relevant to the Digital board but NO replies or interruptions to the data is possible

Bypass Mode Commands

Command “EGSTD”

Reboot Digital board into G-882 digital Standard Mode.

When returning from BYPASS mode to Standard Mode the Digital board will send local commands to the G-882’s CM221 board to turn off all the analogue channels & restore the G- 882 to a state compatible with The Digital operation, this happens in the background with no feedback to the user that this is occurring.

The G-882 digital board will also responds to these G-882 commands while bypassed.

Command “BAUD”

Sets Digital board & G-882 baud rates

Command “RESET”

Resets the Digital & G-882 boards

Command “UPDATE”

Saves changes to the G-882 & the Digital board (i.e. BAUD & Toggles etc.) but only if these have been changed.

4.6.2 G-882 digital Commands Summary Table

Mode commands¹⁰

Cmds “EGxxx”	##	Function	Comments
EGBY P	ALL	[Bypass mode] WARNING: Once in this mode the Digital board cannot communicate with the user	Bypass mode will turn off the Digital functions & activate the data bypass switch so the system operates as a standard G-882 (due to hardware differences the depth and altimeter won’t function in this mode). This mode is saved so that power can be recycled during testing.
EGST D	ALL	[Digital Standard Operating Mode]	EGSTD: Digital Standard Mode Active This mode is saved so that power can be recycled during testing.

4.6.3 Database commands¹¹

Cmds	##	Toggles	Examples
EDA	xx	<u>A</u> ltimeter data	eda00:Tritech PA200,4831.142949<cr><lf>
EDD	xx	<u>D</u> epth sensor data	edd00:Druck 55-882-251,10563520<cr><lf>

¹⁰ Command operates on all concatenated units

¹¹ Command will only function if the specific G-882 address is included

EDF	xx	Fresh Water Calibration data for Depth sensor	edf00: Fresh:S0.017965;B-3.74 <cr><lf>
EDG	xx	G-882 data	edg00:G-882,882999,20000630,C9999,C9<cr><lf>
EDI	xx	Geomatrix GP120 Board_Info	edg00:Geomatrix GP120-100,HW:1.01<cr><lf>
EDL	xx	Altimeter Calibration data	edl00:Alt:S0.002840;B1.16
EDR	xx	Repair History (Most recent only)	Edr00:000; No repair History or eGR00:001;R11394, 2015_02_13, Geometrics<cr><lf>
EDS	xx	Salt Water Calibration data for Depth sensor	eds00: Salt:S0.017336;B-3.73 <cr><lf>
EDV	xx	Digital Board Firmware version	edv00:V01.03

4.6.4 Toggle Commands¹²

Toggles	Cmd	##	Comments ¹³ Cmd → Reply
Altimeter Toggle field & power ON / OFF	ETA	ALL	ETA → ETA (Result \$ strings as shown below)
		xx	ETA00 → eta00:Altimeter OFF \$ 27824.179,S0849,D150.00 ETA00 → eta00:Altimeter ON \$ 27824.179,S0849,D150.00,A25.00
Depth Toggle field & power ON / OFF	ETD	ALL	ETD → ETD (Result \$ strings as shown below)
		xx	ETD00 → etd00:Depth OFF \$ 27824.179,S0849,A25.00 ETD00 → etd00:Depth ON \$ 27824.179,S0849,D150.00,A25.00
Imperial /Metric Toggles between Metric & Imperial Units FOR Depth, Alt & Temp.	ETI	ALL	ETI → ETI (Result \$ strings as shown below)
		xx	ETI00 → eti00:Metric Results \$ 27824.179,S0849,D150.00,A25.00,T31 ETI00 → eti00:Imperial Results \$ 17479.521,S0849,D0492.1,a082.0,t105

¹² 3 Digit Commands operate on all concatenated units / 5 digits commands only operate on the addressed G-882

¹³ All examples assume the address is oo (the first fish)

String Format Toggle Depth & Alt string formats	ETJ	ALL	ETJ → ETJ (Result \$ strings as shown below)
		xx	ETJ00 → etj00:Std. String lengths \$ 27824.179,S0849,D150.00, A25.00,T31 ETJ00 → etj00:Fixed String lengths \$ 17479.521,S0849, D1500, A0250,T31
Field Markers Turns OFF/ON Field Markers	ETM	ALL	ETM → ETM (Result \$ strings as shown below)
		xx	ETM00 → etm00:Markers OFF \$ 43923.951,0849, 150.00, 25.00 ETM00 → etm00:Markers ON \$ 43923.951,S0849, D150.00, A25.00
Pitch & Roll Turns OFF/ON Pitch & Roll Fields	ETP	ALL	ETP → ETP (Result \$ strings as shown below)
		xx	ETP00 → etp00:P&R OFF \$ 43923.951,S0849,D150.00,A25.00 ETP00 → etp00:P&R ON \$ 43923.951,S0849,D150.00,A25.00,P+000,R+ 01

Toggle Commands, continued ¹⁴

Temperature Turns OFF/ON Temperature field	ETT	ALL	ETT → ETT (Result \$ strings as shown below)
		xx	ETT00 → ett00:Temp. OFF \$ 27824.179,S0849,D150.00, A25.00 ETT00 → ett00:Temp. ON \$ 27824.179,S0849,D150.00, A25.00,T31
Water Type Toggles between Salt & Fresh water	ETW	ALL	ETW → ETW (Result \$ strings as shown below)
		xx	ETW00 → etw00:SALT water Depth Sensor Calibration \$ 27824.179,S0849,D150.00 ETW00 → etw00:FRESH water Depth Sensor Calibration \$ 27824.179,S0849,d153.10
Depth Zero		ALL	ETZ → ETZ (Result \$ strings as shown below) If cleared, the Raw depth value will be shown, otherwise the corrected depth value will be shown.

¹⁴ 3 Digit Commands operate on all concatenated units / 5 digits commands only operate on the addressed G-882

Set or Clear zero	ETZ	xx	ETZ00 etz00: CLEAR Depth Zero \$ 27824.179,S0849,D001.30 ETZ00 etz00: SET Depth Zero \$ 27824.179,S0849,D000.00
-------------------	-----	----	--

Example GP120 Strings

Geomatrix Earth Science GP120
 Digital Accessory Bd Geomatrix,
 GP120-4000,HW:4.00
 G-882,882xxx,yyyy_mm_dd,Cxxxx
 Tritech,PAxxx,xxxx.xxxxxx Druck,55-
 882-xx1,xxxxxxx Firmware Version =
 V01.03 Depth Offset is Zero

GP120 Boot Message

\$185944.773,S0010,D0419,A0567,P+000,R+00,T42
 \$185944.773,S0010,D0419,A0567,P+000,R+00,T42
 \$185944.773,S0010,D0419,A0567,P+000,R+00,T42
 \$185944.773,S0010,D0419,A0567,P+000,R+00,T42
 \$185944.773,S0010,D0419,A0567,P+000,R+00,T42

GP120 Full String, Metric (Decimeters) Markers on

\$185944.773,S0010,D041.90,A56.70,P+000,R+00,T42
 \$185944.773,S0010,D041.90,A56.70,P+000,R+00,T42
 \$185944.773,S0010,D041.90,A56.70,P+000,R+00,T42
 \$185944.773,S0010,D041.90,A56.70,P+000,R+00,T42
 \$185944.773,S0010,D041.90,A56.70,P+000,R+00,T42

GP120 Full String, Metric (Meters) Markers on

#		Digits ¹⁵			units
0	\$	1 Digit preamble			
1	Mag Field	10 Digits including 3 decimals			nT
2	Signal	4 digits			-
			Min	Max	
3	Depth (M)	6 digits	-99.99	999.99	Meters
	Depth (dM)	4 digits	0000	9999	Decimeters
	Depth (f)	6 digits	-999.9	9999.9	Feet
4	Altimeter (M)	5 digits	00.00	99.99	Meters

¹⁵ NOTE: digits does NOT necessarily represent possible Max & Min values, just Max. String lengths.

	Altimeter (dM)	4 digits	0000	9999	Decimeters
	Altimeter (f)	4 digits	0000	9999	Feet
5	Pitch	4 digits	-180	+180	Degrees
	Roll	3 digits	-90	+90	Degrees
6	Temp (C)	2 digits	00	99	Degrees C
	Temp (f)	3 digits	000	999	Degrees f

4.6.5 Geomatrix G-882 digital Console

The companion configuration program for the G-882 digital is known as the G-882 digital Console. The aim of this software is to simplify configuring the G-882 digital to the customer required settings prior to the magnetometer being deployed¹⁶.

G-882 digital Test Setup

To configure the G-882 digital it needs to be connected to a PC running the G-882 digital Console program via a serial cable and Junction box to provide power & access to the serial data. Figure 1 shows a typical example of how this can be done.



Figure 42 Typical test setup G-882 digital powered by a Geomatrix GP102 Tow Fish Test Box (in D9 mode) with a Laptop running G-882 digital Console

The above configuration is no doubt familiar to an experienced user so no great detail will be entered into here but a summary follows.

- The Laptop is connected to the J-box serial port, power is also connected to the J-box
- The G-882 digital console program should be started on the Laptop
- Select correct Baud rate (9600 is the default)
- Select correct serial port (Lowest com port is the default)
- Press connect on the console program
- Switch on the G-882
- Data should be seen on the console screen

A more complete description of the above process as it relates to the G-882 digital console program follows.

¹⁶ While this software simplifies the configuration, it is still possible to configure the G-882 digital using a serial terminal and the commands from the G-882 digital USER manual.

The G-882 digital is normally delivered configured for operation with the following default fields enabled.

[\$<mag field>,<Signal>,<depth>,<Altimeter>]

While this is a useful starting point, it should be acknowledged that the customers' requirements may differ; it is the job of the G-882 digital Console to allow the user to easily change the configuration values of a single G-882 digital magnetometer connected to a PC by a serial port.

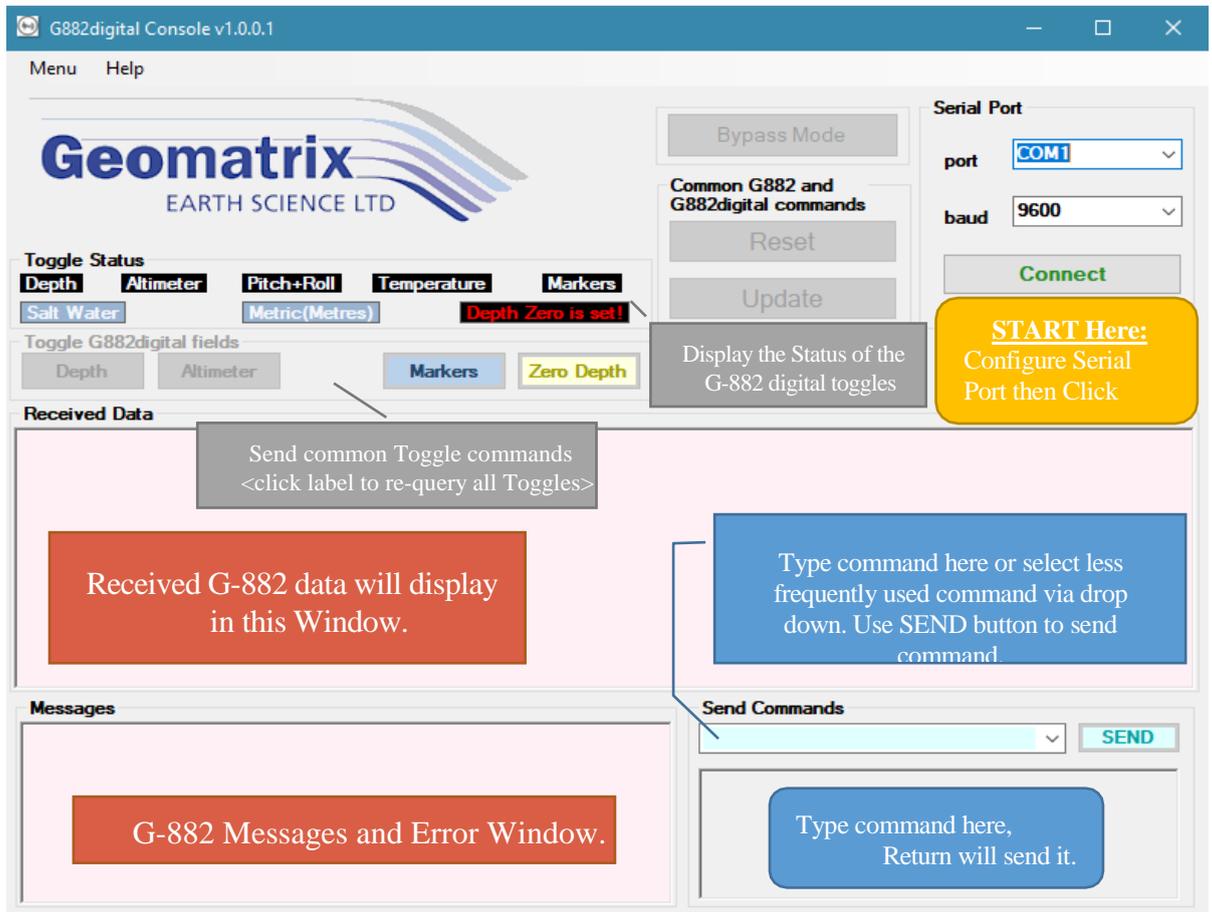
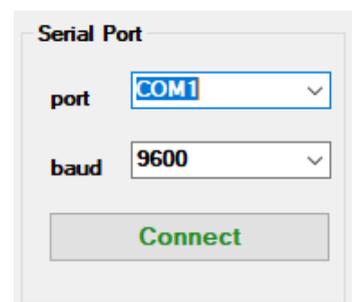


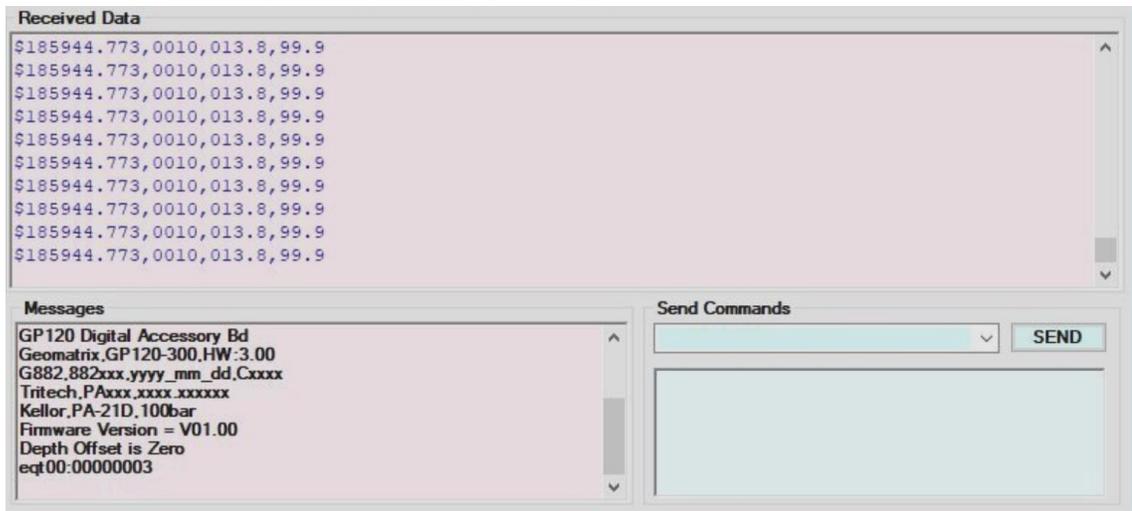
Figure 43 G-882 digital Console Window. Text Boxes explain the functions of major sections.

Serial Port Section

1. The default port defaults to the lowest available comm port, usually [COM1:] if available. Other available ports on the machine can be selected via the dropdown list, these are in alphabetical order. Since the program detects the available ports when the program is run, any USB serial port needs to be inserted before running the program. In the event that no serial ports are fitted to the PC, then program will not run until a serial port is available on the machine.
2. Baud rate defaults to [9600] as this is the most common operating baud rate for G-882's.



- Once the correct serial port & Baud rate are selected, click the [Connect] button, G-882 “\$” data should appear in the Received data Section as shown below¹⁸. All non “\$” strings are considered to be Commands, these will display in the Messages Box, in this case this is the G-882 digital Boot message



Toggle Status Display Section.

As can be seen, on the bottom line of the message box above, once the connect button is pressed, the G-882 digital Console program will attempt to get the current status of the G-882 digital. The console sends out an “ETQ¹⁹” command and expects a reply from the G-882 digital in the format “EQT00:00000003”, the number after the colon is hexadecimal representation of the current toggles which is then used to populate the Toggle status messages as shown below, if a particular option isn’t enabled, the Message locations will be blank. The labels with Black backgrounds are the simple toggles, they will display if the option is on otherwise the label location will be blank. The labels with Blue backgrounds will always display, the default values are shown above.



The Water type label can only show Fresh Water or Salt Water.

Units can have 4 values depending on the ETI/ETJ commands chosen,



See Table 1 ETI/ETJ Truth Table

4.7 Assembly, Installation and Use

4.7.1 Assembly of the Sensor Fish

As can be seen in Figures 54, the G-882 is assembled and ready for deployment, as shipped. The G-882 may be deployed in a nose towed configuration or a center of gravity (CG) towed configuration. Greater tow depths may be obtained using the CG towed configuration. The following will describe how to configure the G-882 for the desired to method. See section 2.6.2 in the **Quick Hardware Guide** for instructions on how to configure each of these tow methods.

DO NOT substitute any other hardware (steel, stainless steel, or anything that you may think is brass) here or anywhere else on the G-882 Magnetometer Fish. Spare hardware is supplied in the Ship Kit. All of the supplied hardware is magnetically tested to insure that it is clean (exhibits no magnetic signature). Failure to follow this caution could introduce heading errors into the data that is acquired making it useless or very difficult to interpret.

4.7.2 Installation of the G-882 Magnetometer

There are several appropriate tie points that can be used to firmly attach the magnetometer tow cable to the vessel. Remember that the tow cable is rated at 4,000 lb. breaking strength (about 700 lbs. working load) and while tension during towing at 5 to 7 knots will be a fraction of that with the standard cable length of 200 feet, catching the sensor fish in a net or rock will transfer that force to the attachment point.

- a. Attach the Kellems grip to a winch if you are using a substantial amount of tow cable. We recommend a winch if the length of the tow cable exceeds 120 m (400 ft.). An on-board deck cable available from Geometrics is used to traverse the distance from the winch installation point to the logging equipment installation site.
- b. The tie point may be on the aft deck. Again an onboard cable is required to traverse the distance from the aft deck to the logging equipment installation place.
- c. The tie point may be close to where the logging equipment is located. A short adapter cable is provided to connect the tow cable to the DC/Data Junction Box. An RS-232 cable will then run from the junction box to the logging computer. A 6 foot cable is supplied but an RS-232 extension cable of up to 40 or 50 feet could be used.

While reading this section, refer to the System Connection Diagram in Appendix B.

The Junction Box functions as the connection point for power and signals required for a functioning G-882 magnetometer system. The Data Logging computer, Junction Box and the power source should be installed in a protected environment. These items are susceptible to water damage and most likely will cease to function if they become wet, particularly with salt water from a sea wave. Their installation could be in the cabin of the boat or the equipment room if there is one. In a very small boat, provide some protection by elevating this equipment from the deck and covering it with a tarp or provide a waterproof enclosure.

4.7.3 Deployment of the G-882 Magnetometer

Turn the power on the DC/Data Junction Box and the Logging Computer. After five minutes warm up for the magnetometer and boot up of the Logging Computer, start the logging software as described in the Quick Start Software Guide or the MagLog™ manual. If you have not previously used the Survey Wizard to set up a survey, do so now. If you have previously created a survey, use the “Start New Survey” from the File menu and then select “Same Hardware as Last Survey” to set the configuration.

If the magnetometer is positioned horizontally on the deck away from any steel objects, you may begin to see readings that represent the intensity of the earth’s field in the survey area. If you are on a steel hulled vessel, you may not see quiet data until you launch the magnetometer fish and it is about 30m (100ft) behind the vessel. With the system running you can proceed to perform the calibration of the depth sensor as described in Section 4.5.4 of this manual.

If the logging software is operating at power-on time, the following outlines what might be observed as the magnetometer is powered-on and warms up to operating temperature. **If the numbers observed are somewhat outside the ranges given below, the magnetometer is still in most situations, operating properly.** Extreme temperature conditions may cause some of these values to go significantly outside these ranges during normal operation.

1. Just after power-on and before the counter begins normal operation some erroneous data may be observed for a brief period of time.
2. When the counter begins normal operation the following may be observed as the magnetometer begins to warm up:
 - A. The magnetometer reading will be erratic as the sensor begins to warm up.
 - B. Analog channel 0, the signal level, will be around 0010 and will increase during warm-up.

- C. Analog channel 1, the depth sensor, will exhibit a value near 0100 (unscaled) with the G-882 in air, out of the water. If no depth sensor is installed in the G-882, the value could vary between 0000 and 0050.
- D. Analog channel 2, the altimeter, will exhibit a value near 9900 (unscaled) with the G-882 in air, out of the water. If no altimeter is installed in the G-882, the value could vary between 0000 and 0050.

If the additional diagnostic analog channels are enabled, the following may be observed:

- E. Analog channel 3, the brightness, will exhibit numbers beginning about 3400, jump to 4300 after a minute or two and then slowly rise towards a number around 5600 as the magnetometer warms up.
 - F. Analog channel 4, the RF, will exhibit numbers beginning low, fairly quickly ramping up to some high numbers and as the magnetometer warms up slowly settling down to a number around 2100.
 - G. Analog channel 5, the heater, will exhibit numbers beginning low, very quickly ramping up to some numbers as high as 3400 (this final value will be determined in part by the ambient temperature) and then settling down to a number around 1600.
 - H. Analog channel 6, if not used, could vary between 0000 and 0050. As shipped, jumpered to an internal voltage, 28V, analog channel 6 could immediately exhibit numbers between 5005 and 7890. If used for an external input (this capability not currently implemented in the G-882), the values will depend upon the characteristics of the user device attached.
 - I. Analog channel 7, if not used, could vary between 0000 and 0050. As shipped, jumpered to an internal voltage, 21V, analog channel 7 could immediately exhibit numbers between 4600 and 5300. If used for an external input (this capability not currently implemented in the G-882), the values will depend upon the characteristics of the user device attached.
3. When the magnetometer is warmed up the following may be observed:
- A. If the magnetometer is properly oriented to the ambient field and not near any large metal objects, a reading indicating the magnitude of the ambient field will be observed.
 - B. Analog channel 0, the signal level, depending on the field magnitude and sensor orientation, a normal signal could vary between 0900 and 1200.
 - C. Analog channel 1, the depth sensor, will exhibit a value near 0100 (unscaled) with the G-882 in air out of the water. If no depth sensor is installed in the G-882, the value could vary between 0000 and 0050. If the G-882 is in the water the value should vary with and be indicative of depth.

- D. Analog channel 2, the altimeter, will exhibit a value near 9900 (unscaled) with the G-882 in air, out of the water. If no altimeter is installed in the G-882, the value could vary between 0000 and 0050.

If the additional diagnostic analog channels are enabled the following may be observed:

- E. Analog channel 3, the brightness, will exhibit a value around 5600, but may vary between 5350 and 5850.
- F. Analog channel 4, the RF, will exhibit a value around 2100, but vary between 2000 and 2400.
- G. Analog channel 5, the heater, will exhibit value around 1740, but vary between 1700 and 1900 depending upon ambient temperature.
- H. Analog channel 6, if not used, could vary between 0000 and 0050. As shipped, jumpered to an internal voltage, 28V, analog channel 6 could exhibit a value around 6500, but vary between 5005 and 7090. If used for an external input (this capability not currently implemented in the G-882), the values will depend upon the characteristics of the user device attached.
- I. Analog channel 7, if not used, could vary between 0000 and 0050. As shipped, jumpered to an internal voltage, 21V, analog channel 7 could exhibit a value around 5100, but vary between 4600 and 5300. If used for an external input (this capability not currently implemented in the G-882), the values will depend upon the characteristics of the user device attached.

In either configuration above, nose or CG tow, the magnetometer can be lifted over the side by one person. However, the deployment will be much easier and smoother with two or more people handling the operation. Due to much lower levels of drag force, the nose towed magnetometer may be handled by one strong person. Cowhide work gloves provide the best protection and grip for handling the wet tow cable.

There are two methods to handle the cable on deck if a winch is not used:

1. Neatly fake (figure eight) the cable down on the deck beginning with the onboard end. As this is done remove any twists in the tow cable. The cable may be deployed from the figure eight without knots and kinks. One person should be assigned to tend the cable on and off of the figure eight. This method is better for cable up to 120m (400ft).
2. Neatly lay the cable out in long loops bow to stern on the deck beginning with the onboard end. As this is done remove any twists in the tow cable. The cable may be deployed from the loops on the deck without knots and kinks. One person should be assigned to walk the loops back on the deck during retrieval. This method works well with cables up to 60m (200 ft.).

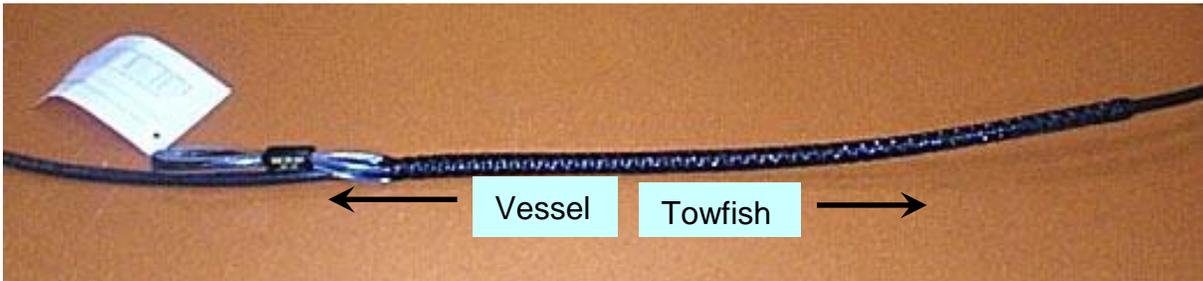
Tow cables longer than 90m to 120m (300ft to 400ft) should probably be handled with a winch.

Manual deployment, is best handled with two people, especially when additional depressive weights are being used, a third person should manage the tow cable. The vessel should be making 1 to 1 ½ knots during deployment. It may be necessary to increase the vessel speed as more cable is deployed to prevent the magnetometer from striking the bottom. The more quickly the desired cable length can be deployed and the desired tow speed attained reduces the chances of the magnetometer going too deep striking the bottom or becoming hung. The recommended cable management mentioned above will aid in quick deployment. Another method is to stop playing out tow cable a few times during deployment while under tow. This will allow the tow fish to rise towards the surface. If a CG towed fish with a depressor wing is being deployed, it pulls with significant force. It may require two or three people to hold it during the play-out stops.

It is best if the tow cable is tied to the vessel before the vessel begins to acquire the desired tow speed. The magnetometer with the depressor wing produces strong pull forces under tow speed of 4 to 6 knots.

Determine the approximate length of tow cable to be deployed to achieve the required survey depth. We recommend that the Kellems grip provided on the tow cable be used to secure the tow cable to the towing vessel. Slide the Kellems grip to set the length of tow cable desired to be deployed plus some additional cable to account for the distance from the ship to the cable water entry point. Secure the Kellems to the tow cable as shown in Figure 43. **DO NOT** tape along the whole length of the Kellems; this will prevent it from working properly. Attach the Kellems to the towing vessel using a strong line tied to the loop of the Kellems grip.

A Kellems grip is like a child's toy finger trap. The stronger the forces that pull on it, the tighter it grips the cable. If the Kellems grip needs to be moved to adjust the amount of tow cable deployed, remove the tape anchoring it to the tow cable and compress each end to the Kellems towards the other along tow cable. This will expand the Kellems and allow it to slide easily along the cable to its new position. Release the ends of the Kellems, re-anchor the end towards the tow fish as shown Figure 43 and then smooth it back down along the cable towards the vessel.



Use a strong line to attach this loop to the vessel.

Figure 44. Kellems grip installed on the tow cable.

Retrieval is best performed with the vessel at full stop (propeller not turning) or maintaining just enough headway to keep the cable from going under the vessel. The intent is to prevent the tow cable from becoming entangled in the propellers. Nothing destroys surveys and propeller shafts quicker than entangling the tow cable in the propellers.

Retrieve the cable as quickly as possible to help prevent the magnetometer from striking the bottom. Again, neat tow cable management as described above will greatly facilitate survey execution.

It is recommended that some form of quick communications be provided between the vessel captain and the magnetometer handlers. This will greatly ease handling and make the operation safer. Radios work well.

The tow cable length is generally determined by a number of factors. The most important factor is the desired depth of tow that must be achieved for the survey. The longer the cable, the greater tow depth. The depth of tow may also be improved by the type of towing method selected for the magnetometer tow fish.

For shallow surveys on short tow cables (30 to 60 meters), the Nose Tow method works the best. One man can manage deployment and retrieval with a second man to manage the tow cable. The depth of tow graph below for a nose towed G-882 is derived from actual tests. However, it **DOES NOT** provide exact numbers. It is just intended to provide an indication of the tow depths that might be expected. The actual depth of tow can be affected by water current speed and turbulence. Also, turns to change course greatly slow the speed of tow increasing the tow depth. If you know you are towing in an area that may have potential snags upon which the tow fish may hang, retrieval of tow cable in the turns may be required to manage the tow fish depth guarding against snagging. This graph is provided as a suggestion of what tow depths might be expected using a nose towed G-882 magnetometer.

G-881 Nose Tow Depth vs Speed on a 175 ft Cable Length

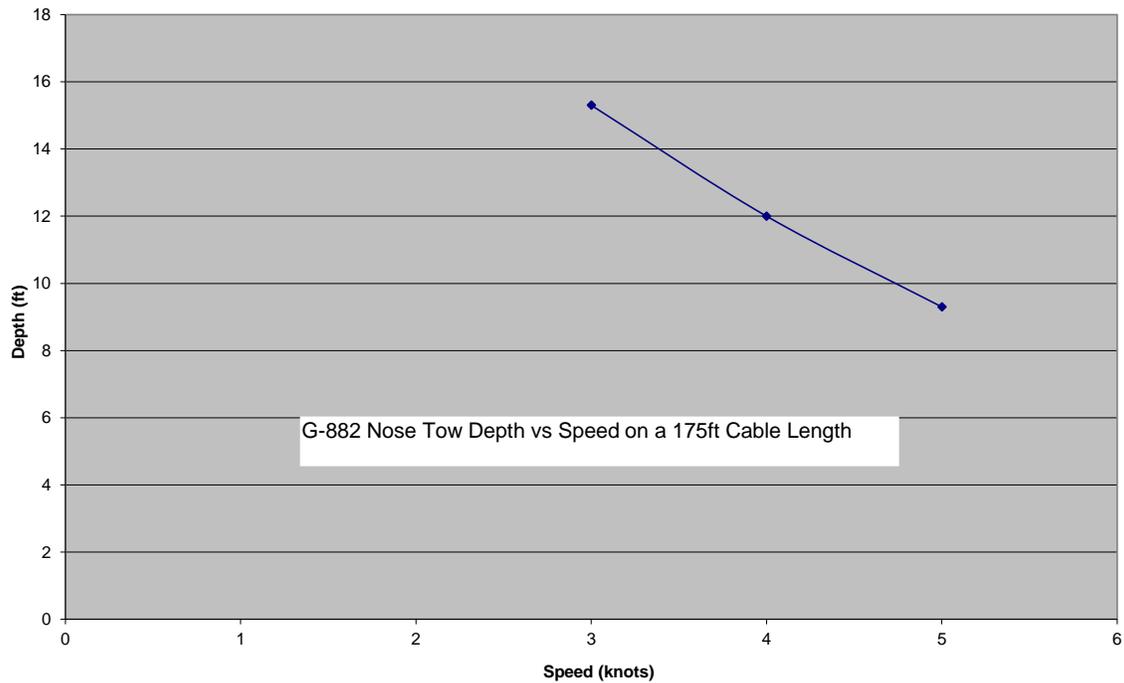


Figure 45

Towing a magnetometer fish from its center of gravity provides a method to allow the fish to be towed deeper, hence closer to the bottom for a better detection range. Generally, a CG towed G-882 will tow one to two Meters deeper than when nose towed. Adding a depressor wing to the tow cable may double the tow depth. Geometrics offer both options for the G-882. The following provide information regarding tow depths that may be expected and instructions for assembling.

The following graphs provide an approximate indication for tow depths that may be expected versus the cable length deployed versus the speed of tow. These graphs are derived from actual tests. However, they **DO NOT** provide exact numbers. The actual depth of tow can be affected by water current speed and turbulence. Also, turns greatly slow the speed of tow increasing the tow depth. If you know you are towing in an area that may have potential snags upon which the tow fish may hang, retrieval of tow cable in the turns may be required to manage the tow fish depth guarding against snagging.

G-881 CG Tow Cable Length vs Depth

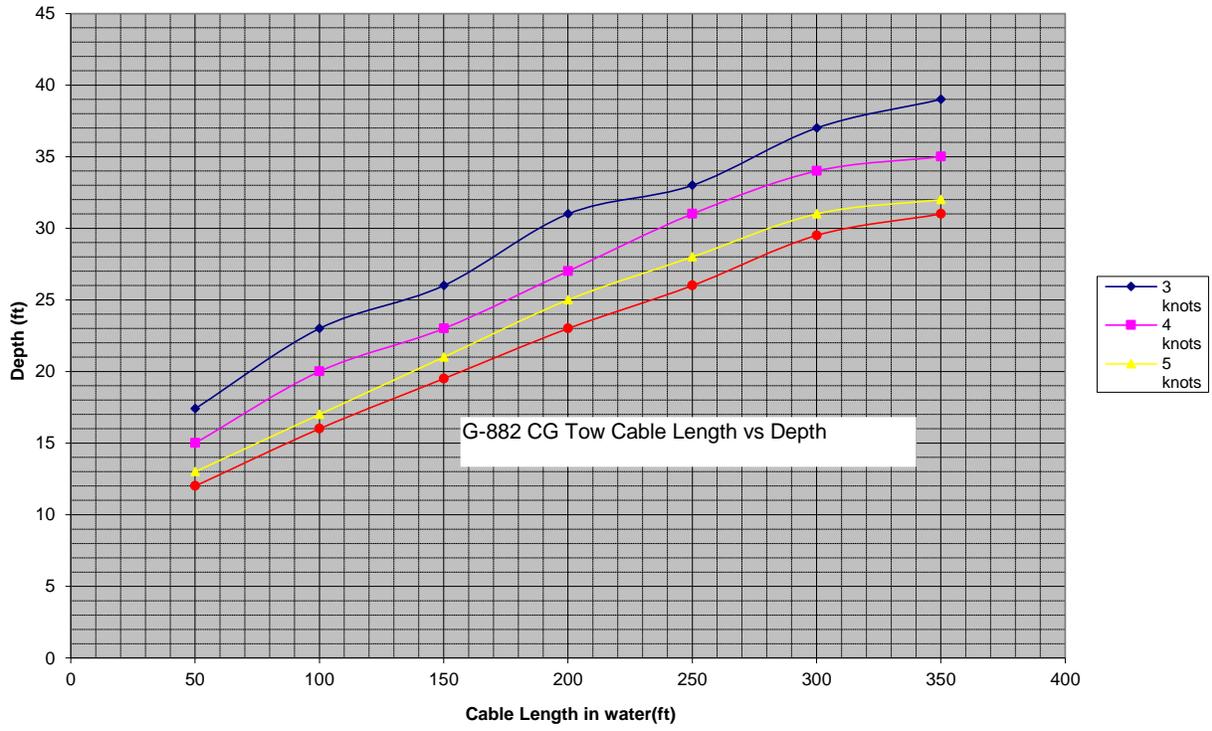


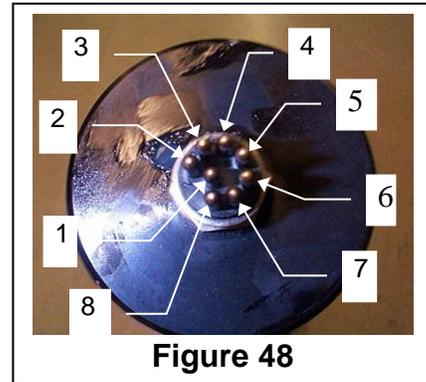
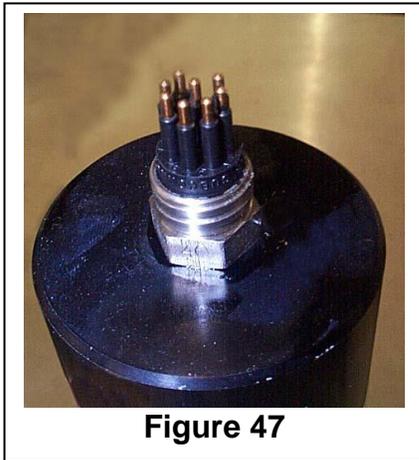
Figure 46

5.0 Service Information and Trouble Shooting Guide

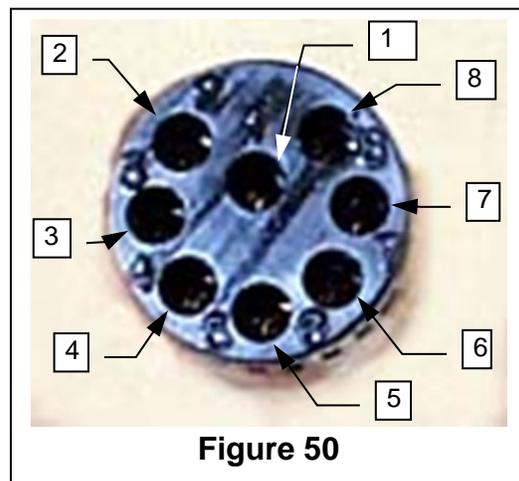
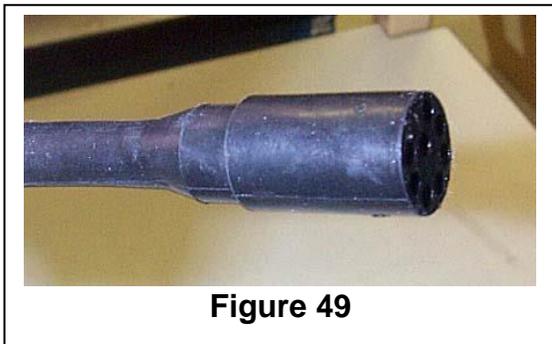
It is possible to open the G-882 in the field, but is not recommended. There are no easily assessable parts that can be field serviced. It is recommended that if service is required, the G-882 be returned to the factory for service.

5.1 Connector Information

The following Figures provide views of the connectors used on the G-882 tow cable.



Figures 47 and 48 show the male water tight connector on the nose bulkhead of the G-882 magnetometer. Figure 48 also shows the pin numbers for this connector. The Geometrics part number for this connector is 21-236-400.



Figures 49 and 50 show the female water tight connector on the wet end of the tow cable. This connector mates with the connector of Figures 51 and 52. Figure 50 also shows the pin numbers for this connector. The Geometrics part number for this connector is 21-236-410.

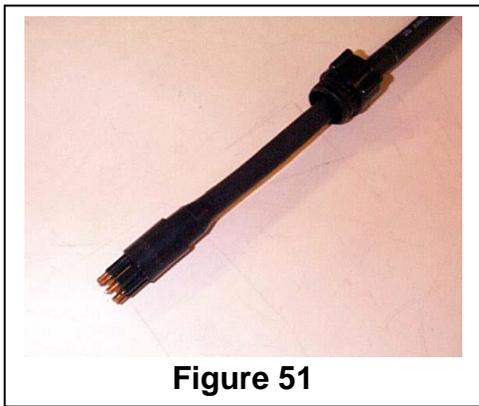


Figure 51

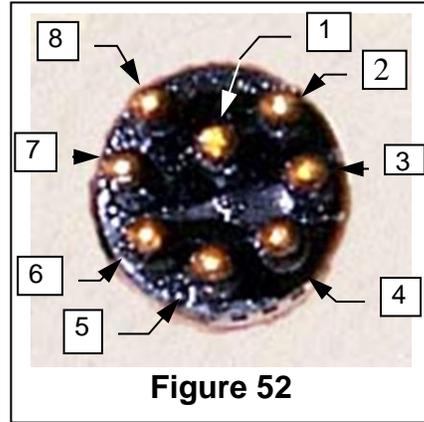


Figure 52

Figures 51 and 52 show the male water tight connector on the dry end of the tow cable. This connector mates either to the adapter cable shown below or to a winch if one is used. Figure 52 also shows the pin numbers for this connector. The Geometrics part number for this connector is 21-236-411.



Figure 53

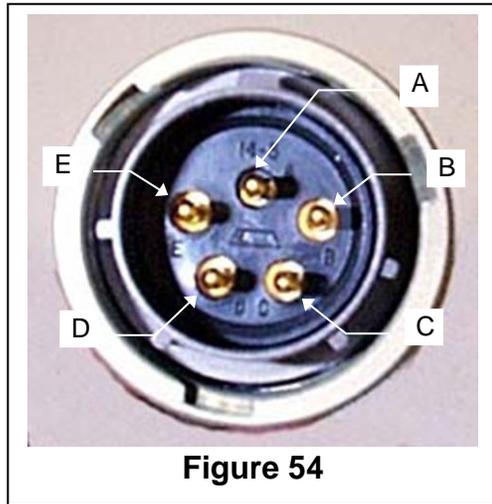
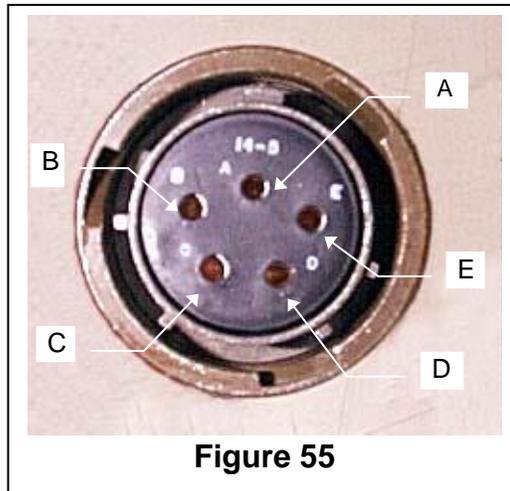


Figure 54

If the tow cable purchased with your system is terminated as shown in above in Figure 53, an adapter cable as shown in Figure 54 is provided to allow connection the DC/Data Junction Box. The connector on the left in Figure 53 is a Bendix connector. It mates with the connector labeled ONBOARD on the DC/Data Junction Box. Figure 54 shows the pin numbers for the Bendix connector.

The connector that should be connected to the tow cable is the same as the wet end of the tow cable shown in Figures 49 and 50. This end should be mated with the dry end of the tow cable. Prepare these connectors for installation by insuring that the connectors on the tow cable and the adapter cable are clean and free of dirt. Using a finger, wipe a small amount of silicon grease across the face of the connector of the adapter cable. If this is done properly, there will be a “half-moon” of grease visible in each of the pin sockets of this connector. The correct silicon grease is provided in a small circular, snap-lid container in the ship kit. Unless it is cleaned, once greased this connector may never require grease again.



The connector shown in Figure 55 is the DC power connector on the AC/DC power supply. The connector in Figure 54 is a Bendix connector. It mates with the connector labeled 22-32 VDC on the DC/Data Junction Box. Figure 55 shows the pin numbers for the Bendix connector.

5.2 O-ring Maintenance

The O-rings **do not** require maintenance. Unless the bulkhead is removed from the magnetometer fish, the O-rings do not require maintenance. Geometrics does not recommend the customer open the magnetometer fish under any circumstances. There are no customer maintainable parts within.

Should the customer inadvertently remove a bulkhead or do so under instructions from Geometrics, the following procedure should be observed to re-install the bulkhead.

Remove the two O-rings from their grooves on the bulkhead. Using a clean towel, clean any contaminants that may be observed on the barrel of the bulkhead or in the O-ring grooves. Inspect the inside of the magnetometer fish from where the bulkhead was removed. Clean any contaminants that may be observed.

Take the two replacement O-rings provided in the ship kit and apply some silicon grease provided in a small circular, snap-lid container in the ship kit. Take a little grease between your thumb and index finger. Gently pull the circumference of the O-ring between your greased fingers to thoroughly apply a complete layer of grease to the O-ring. Gently stretch the O-ring over the small end of the bulkhead and slide it into one of the O-ring grooves. Repeat this process with the second O-ring and place it in the other O-ring groove of the bulkhead. Take a little more grease on your index finger and wipe it on the circumference of the O-rings on the bulkhead.

Install the bulkhead into the magnetometer fish. Push the bulkhead straight in to insure proper installation.

5.3 Depth Sensor Ratings

There are four choices for a Depth Sensor that may be installed in a G-882.

They are: none
100psi
250psi
500psi

These depth (pressure) sensor(s) will operate to 200% (for a 100psi sensor this would be 200psi) over pressure without damage or the calibration change. Exceeding 200% may cause a permanent change in the calibration as the sensor is permanently deformed. Sensor failure to produce data may occur if 200% over pressure is exceeded.

These depth sensors are safe from bursting up to 400% over pressure without bursting. The pressure sensor will be useless after this over pressure but it should not burst protecting the magnetometer from flooding. The pressure sensor will not burst at exactly 400% over pressure and may survive higher pressure without bursting. **However, if pressure is approaching 400%, every effort should be immediately undertaken to prevent the G-882 from going deeper to prevent bursting of the depth sensor.**

5.4 Tow Cable Strength Data

Recent design changes have made a stronger tow cable available. Data for both the "original" and the "new" cable are provided for those who may have the original cable with a magnetometer previously purchased from Geometrics.

Original Tow Cable

Color: black
Marking: GEOMETRICS, INC., P/N 60-453-095
Breaking Strength: 4000 lbs.
Maximum Working Load: 800 lbs.

Minimum Bend radius: 4.5 in.

New Tow Cable

Color: Green

Marking: GEOMETRICS, INC., P/N 60-453-101

Breaking Strength: 4000 lbs.

Maximum Working Load: 600 lbs.

Minimum Bend Radius: 6 in.

The working loads exerted on the tow cable by the G-882 vary depending on the type of towing method used. The lowest amount of force exerted is the G-882 nose tow configuration. Next is the CG towed configuration. Care should be taken to minimize the working load exerted on the tow cable. Exceeding the maximum working load, will, over time, cause the tow cable to fail electrically. The conductors may become work hardened and break. Following are some suggestions to minimize the work load:

1. Keep the tow speed to a maximum of six knots.
2. Slow the vessel down to 1-2 knots to retrieve tow cable.
3. Slow the tow speed in high seas to reduce the effect of heave on the tow cable, or cease the survey.

Should the tow fish become snagged, the much higher breaking strength may help insure that the tow fish is successfully retrieved. However, this will exert loads on the cable well in excess of the working load. Before the cable is used again it should be carefully inspected and tested. It may still be usable, but its life will have been shortened. How much, depends upon how close to the breaking strength the force induced by the snag was.

5.5 Trouble Shooting Guide

****Please see important note about Voiding of Warranty in section 1.2 of this Manual before attempting any repairs to the instrument. ****

Always record Serial Number, Signal Level, Sensor Orientation, and Latitude/Longitude before contacting Geometrics.

1. Power check (Use MagLog Diagnostic Survey or multiply channel 7 by 0.004805 then subtract 2.048 to scale to Volts DC)
 - a. Minimum 24 Volts DC at electronics bottle
 - b. Maximum 33 Volts DC at electronics bottle
 - c. Starting current 1 Ampere at 28 Volts
 - d. Running current 0.3 to 0.6 Ampere at 28 Volts depending upon ambient temperature
2. Connector checks
 - a. Dirt or corrosion
 - b. Bent pins
 - c. Backshell tight
3. Cable jacket check
 - a. Kinks
 - b. Abrasions
 - c. Cuts
4. Sensor orientation
 - a. Use MagPick IGRF and CSAZ to model sensor behavior
 - b. Adjust sensor orientation and observe dead zones
 - c. Return sensor to correct orientation for the survey area
5. Field readings
 - a. Reasonably close to MagPick IGRF model estimate
 - b. Sample to sample noise less than 0.1 nT when not moving.
6. Field Larmor amplitude check – Signal should be at least 800 when correctly oriented. Maximum signal should be less than 2500.
7. Larmor amplitude check and adjustment (Authorized Repair Facility only)
 - a. Pot on GSN to adjust for 1.5 to 2.0 Volts Peak to Peak at 50,000 nT after 20 minute warm up.
8. Heater check and adjustment (Authorized Repair Facility only)
 - a. 34.5 K ohms after warm up

Symptom	Probable Causes	Corrective Actions
Long warm-up time	<p>Low voltage</p> <p>Faulty sensor cable connection</p> <p>Heater setting too cool</p> <p>Excessive cold</p> <p>Defective internal sensor or electronics components</p>	<p>Increase voltage (minimum 24 VDC at the electronics) or repair the Coax cable</p> <p>Connect the fish directly to the deck cable or cable adapter</p> <p><i>Disconnect sensor from electronics and carefully clean the pins and sockets*</i></p> <p>Adjust heater to 34.5 Kohms*</p> <p>Normal – allow extra time for sensor to warm up in extremely cold environments</p> <p>Return fish to Geometrics for repair</p>
Noisy magnetic field readings	<p>Sensor not oriented correctly</p> <p>Magnetically “Noisy” location</p> <p>Signal amplitude too low</p> <p>Sensor cable or connector worn or damaged</p>	<p>Use MagPick IGRF and CsAz software to model magnetic field and sensor behavior, then determine a correct orientation</p> <p>Move to a magnetically clean area</p> <p>See next section on low signal causes</p> <p>Replace sensor cable and connector assembly. Check connector on electronics module for wear and replace if required*</p>
Low Signal Level	Sensor not oriented correctly	Use MagPick IGRF and CSAZ software to model magnetic field and sensor

Symptom	Probable Causes	Corrective Actions
	<p>High magnetic gradient</p> <p>Low power supply voltage</p> <p>Heater setting incorrect (too hot or too cold)</p> <p>Insufficient warm up time</p> <p>Signal adjustment is set wrong</p>	<p>behavior, then determine correct orientation.</p> <p>Check gradient by moving sensor back and forth East/West, North/South, and Up/Down while noting changes in the magnetic field. Signal level diminishes rapidly when the magnetic field is changing by more than 200 nT per foot. Move the sensor to a less magnetically cluttered area if the gradient is more than 200 nT per foot.</p> <p>Increase power supply voltage (minimum of 24 VDC at the electronics).</p> <p>Adjust heater such that the temperature sensing thermistor stabilizes at 34.5K ohms*</p> <p>Allow 20 minutes for the magnetometer to warm up and stabilize (longer in extreme cold).</p> <p>Adjust signal level*</p>
Sensor connector damaged or worn	Handling, mechanical problem, accident, or normal wear.	Correct handling or mechanical problem. Then replace sensor cable and connector*
Excessive current consumption.	Defective sensor or electronics	Return fish to Geometrics for repair.
		*Authorized repair shop only

****Please see important note about Voiding of Warranty in section 1.2 of this Manual before attempting any repairs to the instrument. ****

5.6 The Diagnostic Survey – How to use it

Geometrics is now distributing a Diagnostic Survey as part of the MagLog software that can be downloaded from the Geometrics ftp site:

<ftp://geom.geometrics.com/pub/mag/Software>

Choose the file, [MagLog_latest.exe](#) to download and install MagLog with the Diagnostic Survey. The Diagnostic Survey will be installed in the same directory as MagLog, usually:

[C:\Program Files\Geometrics](#)

You can now Start a new survey and use the Diagnostic Survey as a template.

Normal values for the various slots are:

mag – A trace indicating magnetic field variations

signal – Between 600 and 1500 after 15 minutes of operation with the sensor properly oriented

depth – Between 100 and 9900

alt – Between 100 and 9900

Bright – Between 5332 and 5893 after 15 minutes of operation

RF – Less than 2500 after 15 minutes of operation

Heat – Approximately 1600 at room temperature. Maximum is about 3400 and minimum is about 0800

+28V – Between 24.0 and 33.0

+21Va – Between 20.0 and 23.5

Start by choosing Start New Survey from the File menu.

Next choose a location for your survey.

You can choose to make a new folder by clicking on the icon with an asterisk, then naming the folder as shown below.

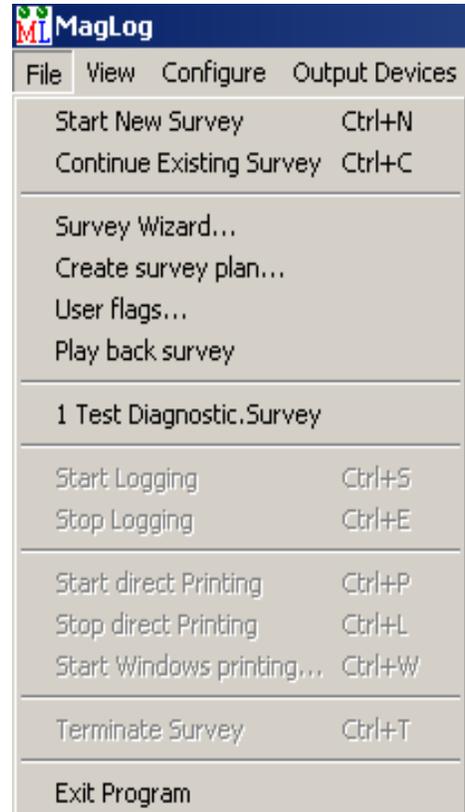


Figure 56

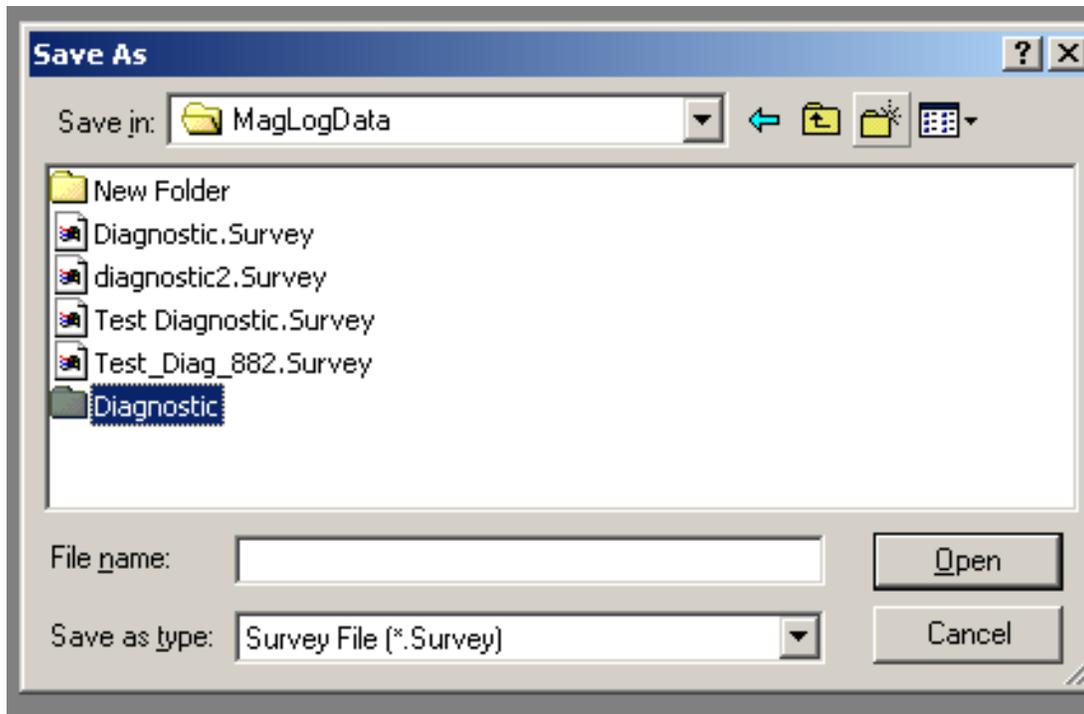


Figure 57

Press the Enter Key after naming the new folder until the Save As dialog box shows no files or folders.

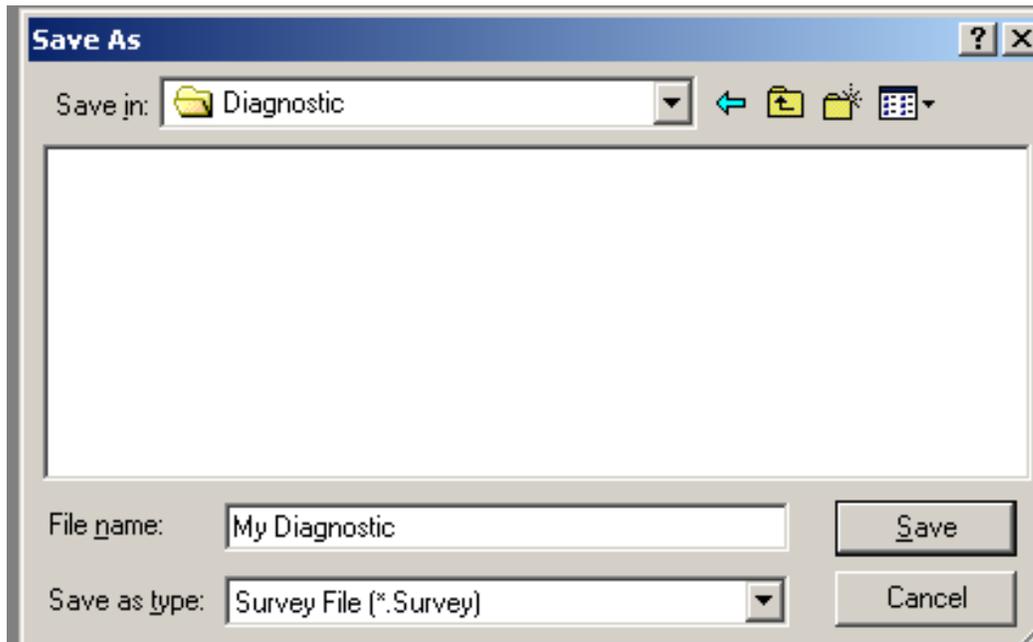


Figure 58

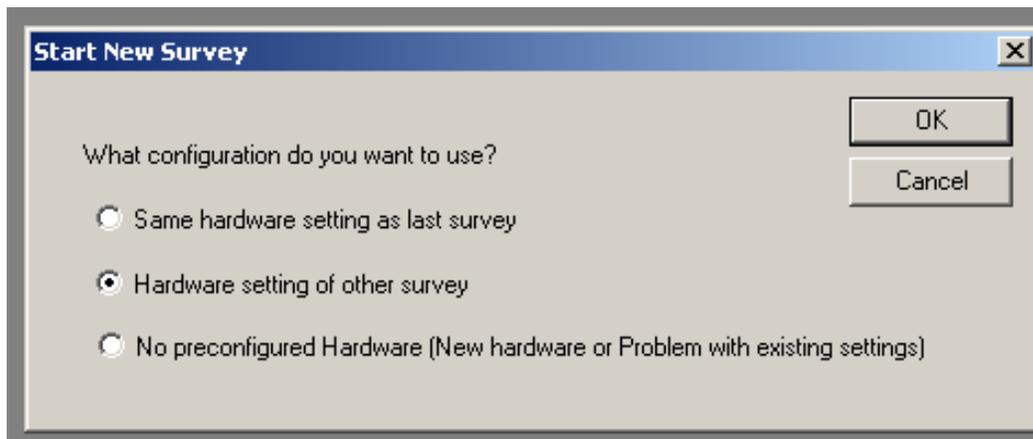


Figure 59

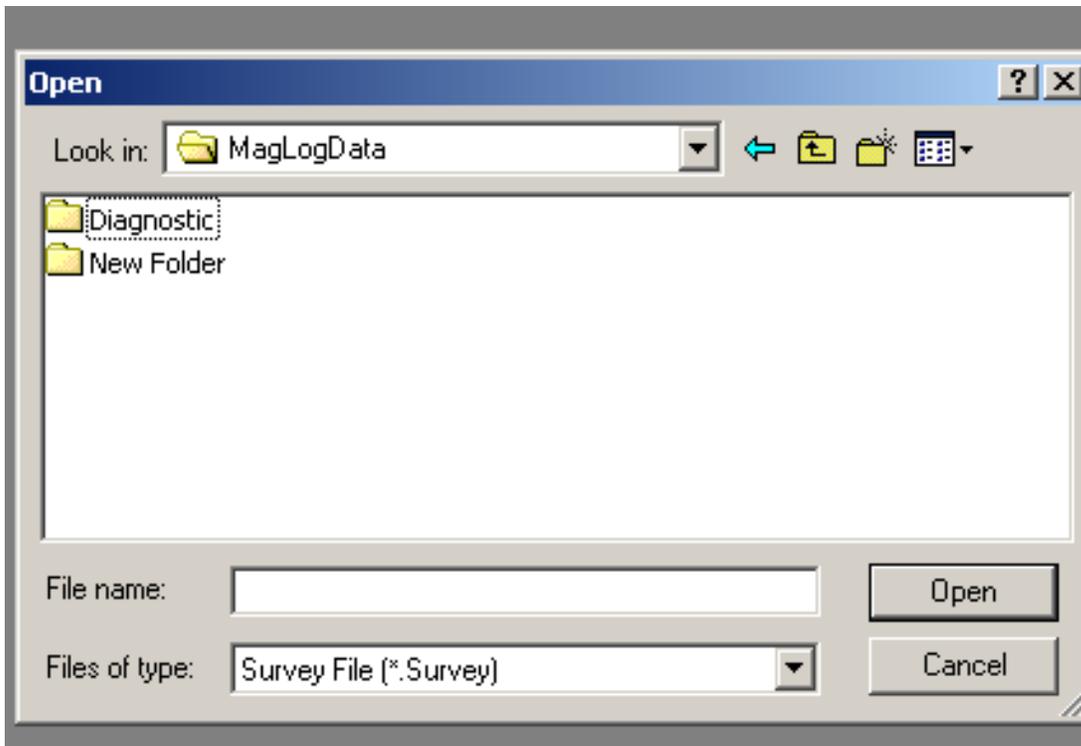


Figure 60

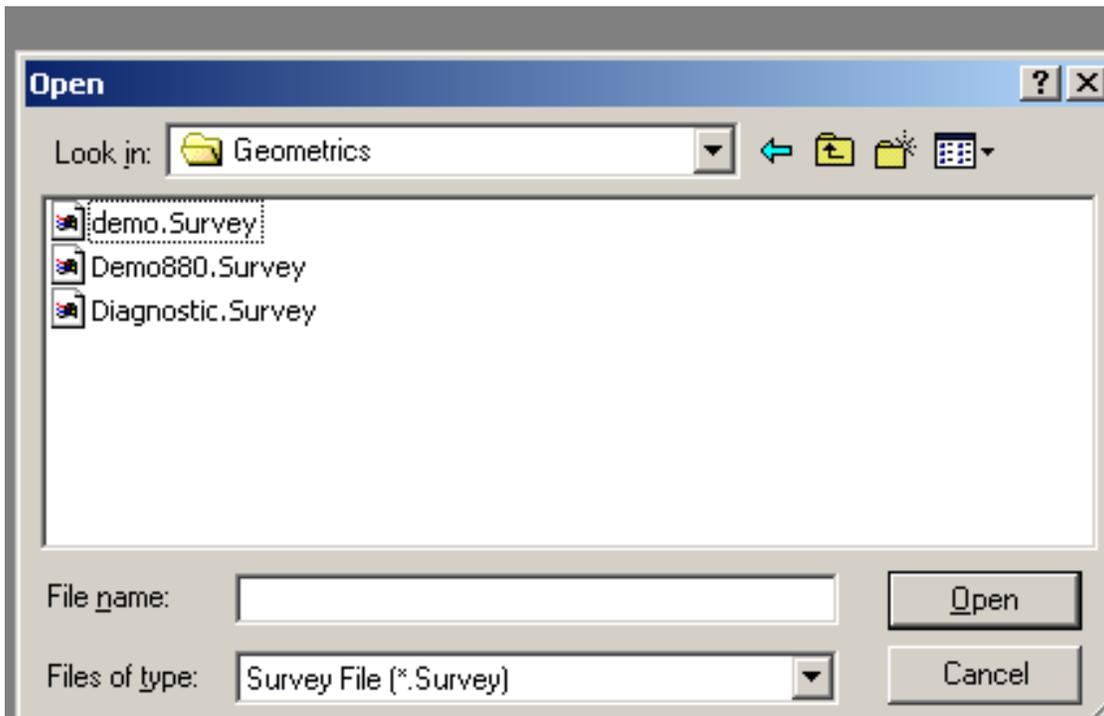


Figure 61

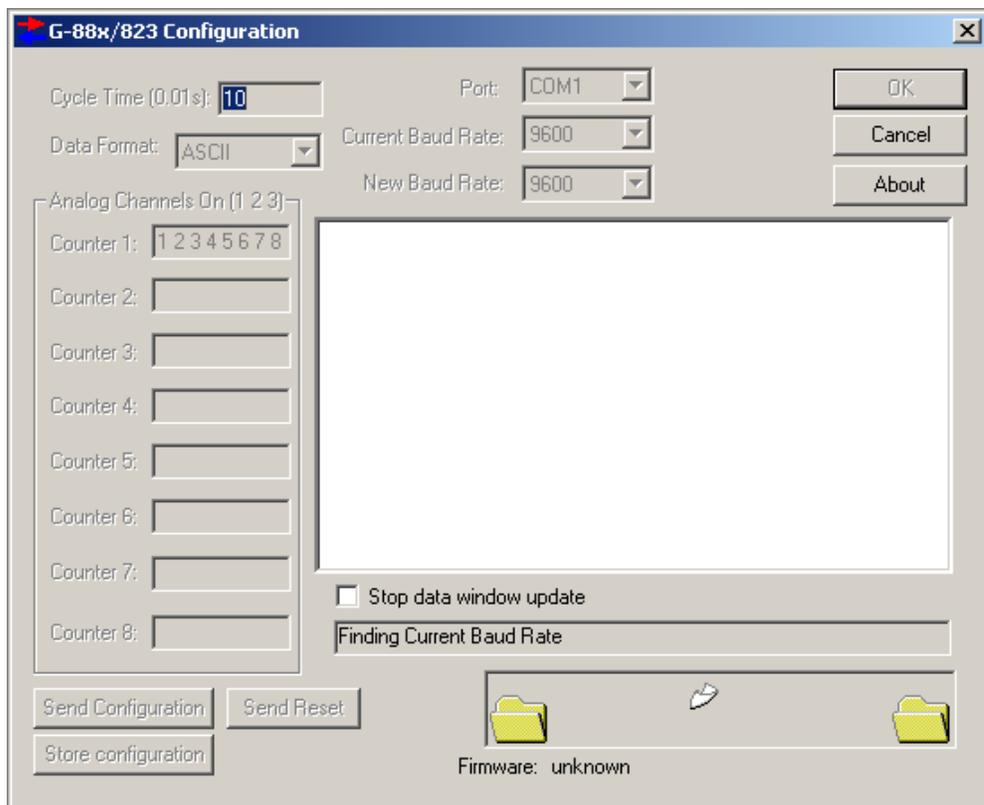


Figure 62

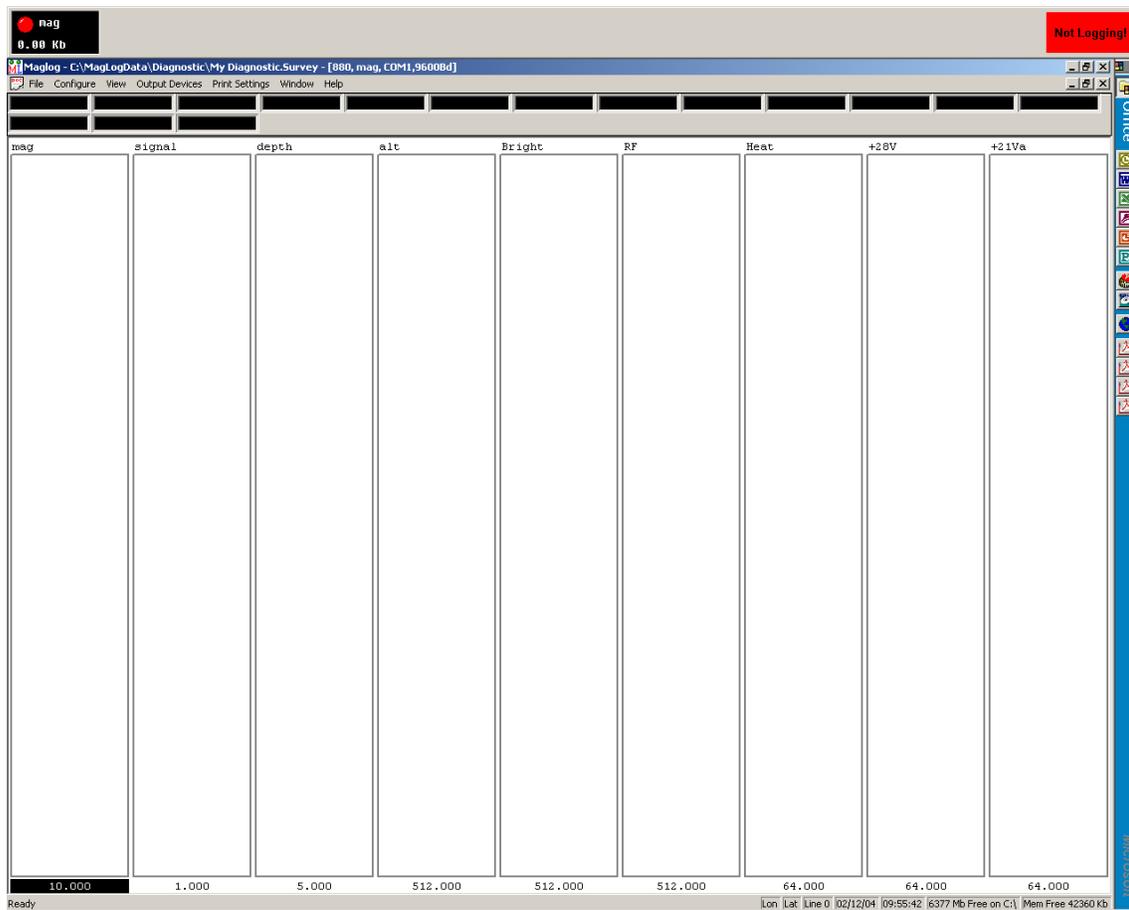


Figure 63

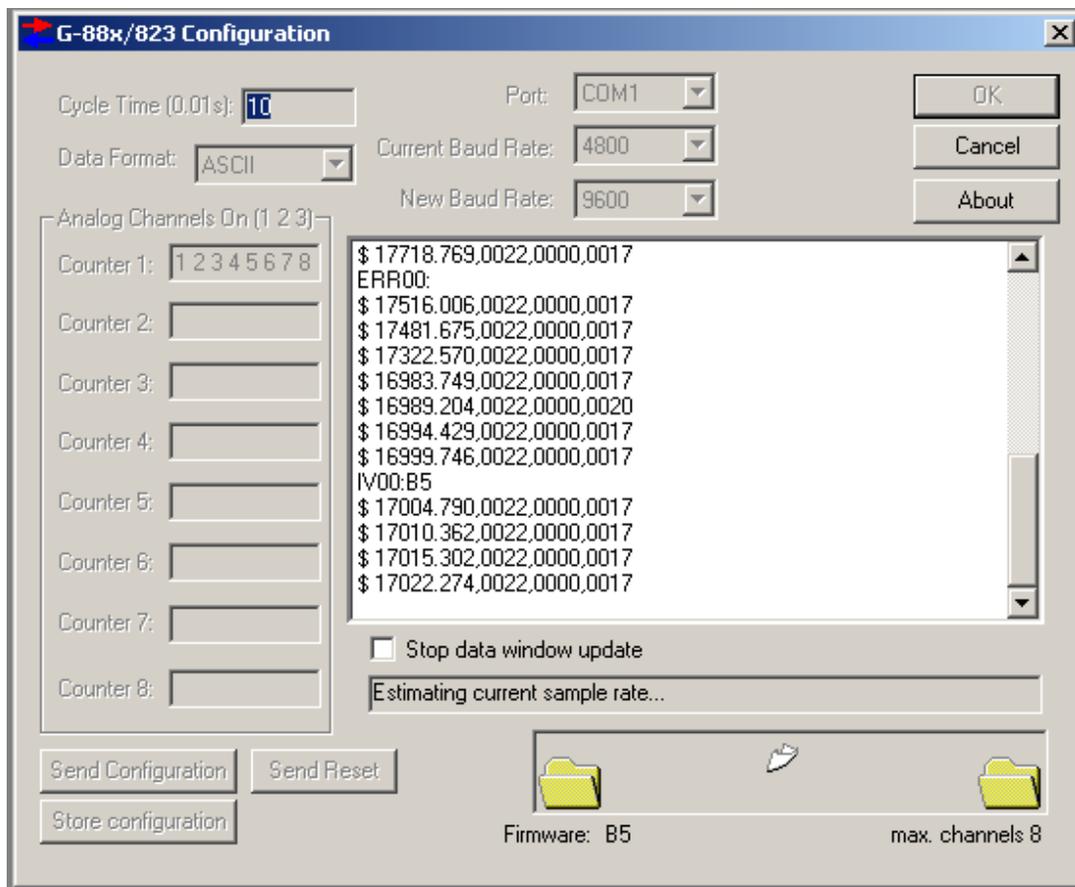


Figure 64

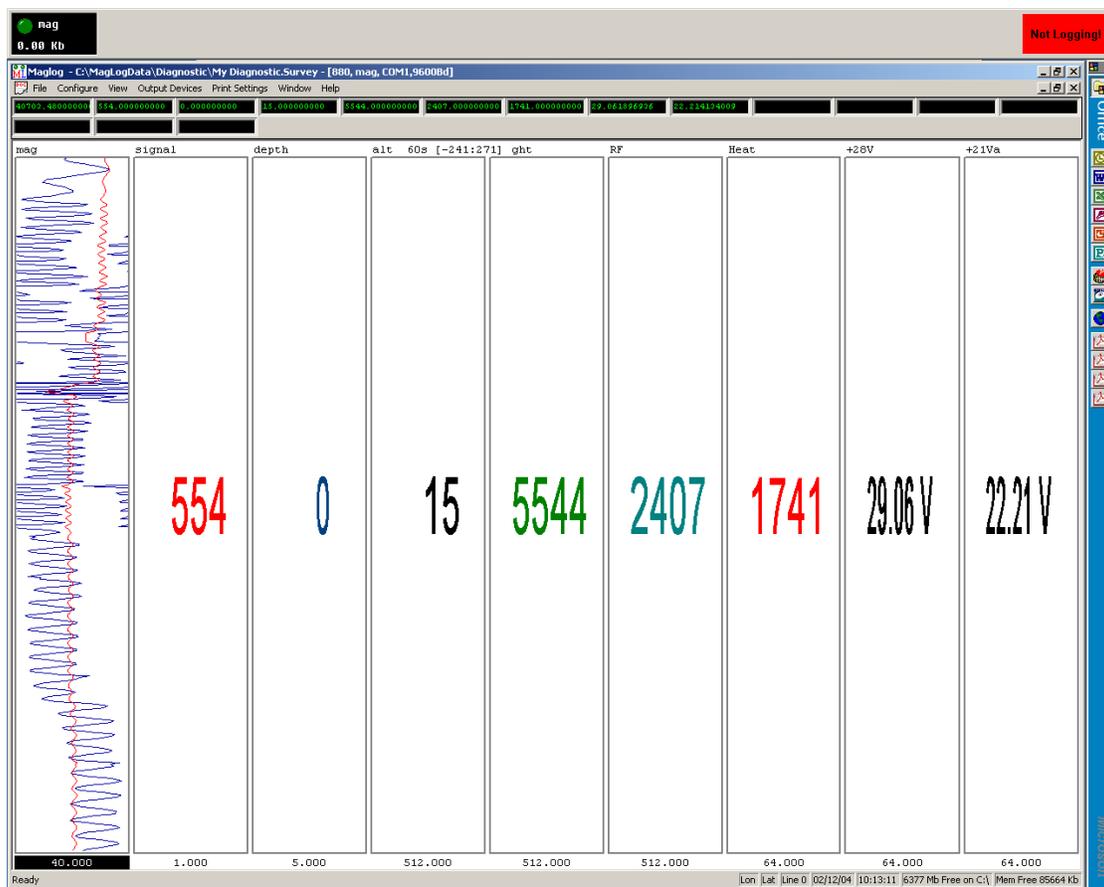


Figure 65

Final MagLog screen will look as above to provide diagnostics for system troubleshooting.

5.7 Voltage Calibration for Magnetometers using CM-221 Counters

You can apply the following Scale and Bias to Channel 7 to calibrate the +28 Volt measurement available in these models:

Scale 0.004805
 Bias -2.048

You can apply the following Scale and Bias to Channel 8 to calibrate the +21 Volt measurement available in these models:

Scale 0.004805
 Bias -2.048

Please refer to the following pages to see examples of the screens displayed during this calibration.

MagLog Screens

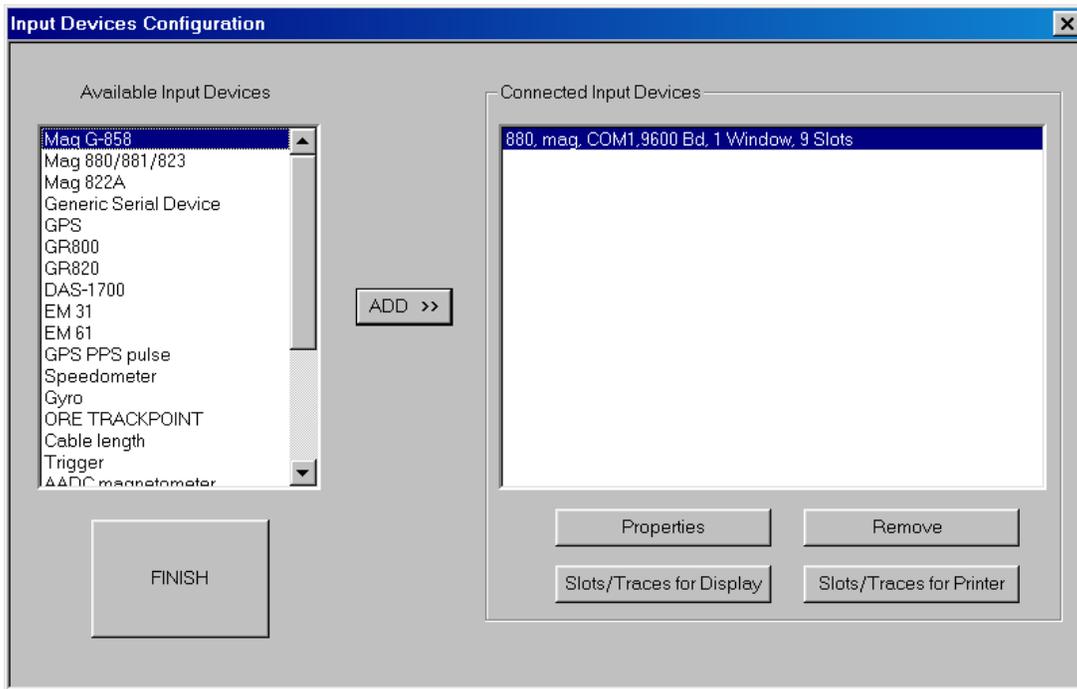


Figure 66

Click the Configure menu item and choose Input Devices. Then highlight the magnetometer device and click Properties.

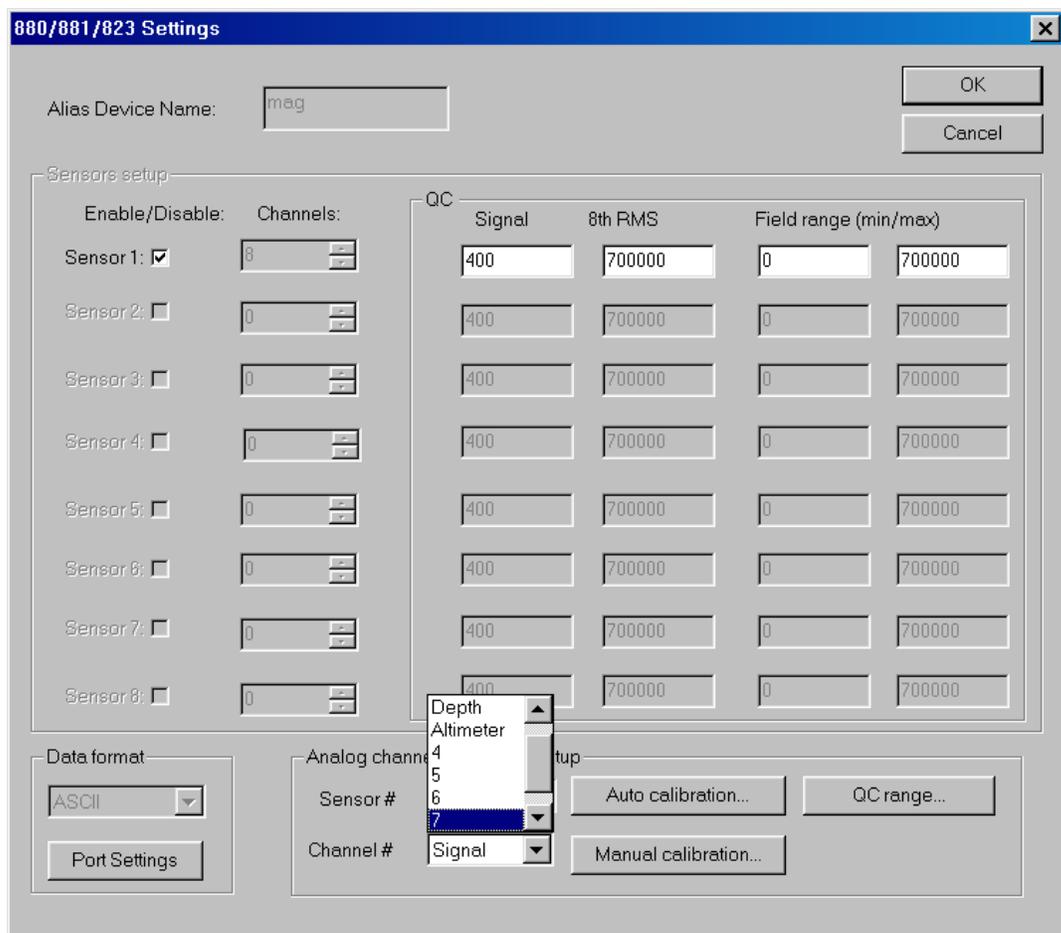


Figure 67

Click Channel number and choose 7 to apply calibration coefficients for +28 Volts or choose 8 to apply calibration coefficients for +21 Volts.

Then click on the Manual calibration... button to enter Scale and Bias.

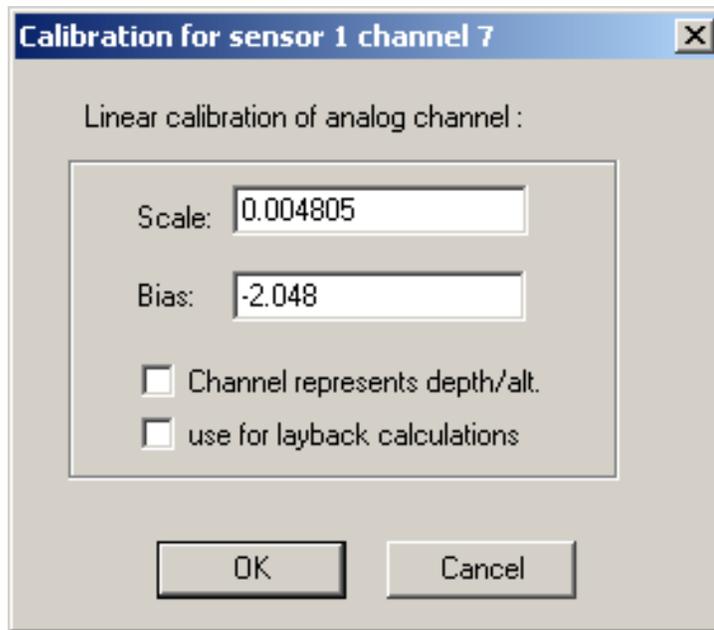


Figure 68

Scale and Bias for +28 Volts are shown above.

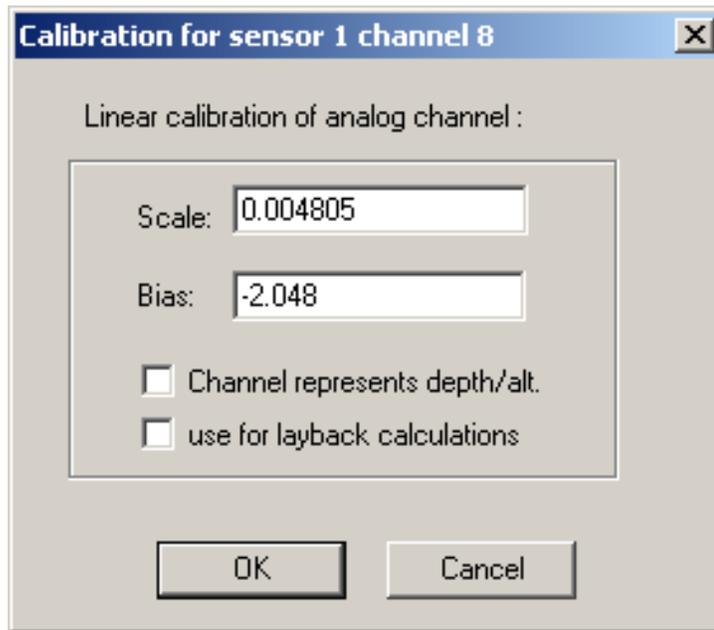


Figure 69

Scale and Bias for +21 Volts are shown above.

MagMap Screens

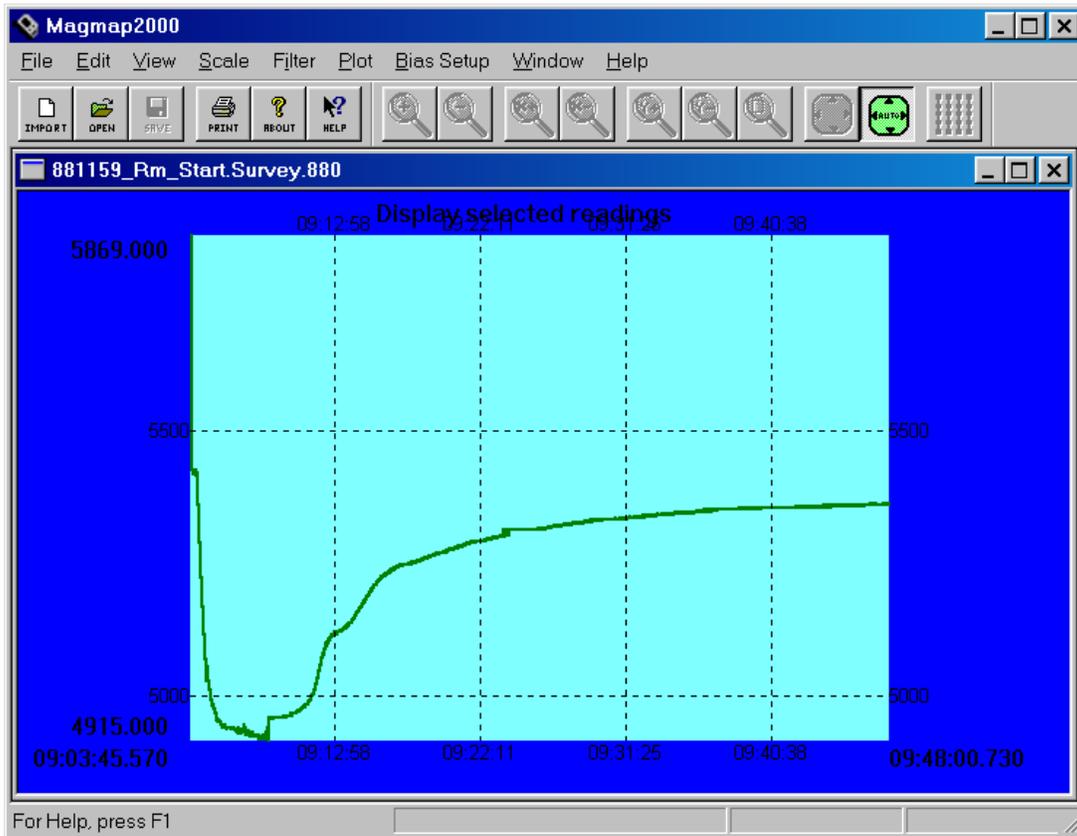


Figure 70

Select the magnetometer data from the various windows displayed in MagMap after opening a Survey File. Then right-click the center of the display area and choose the appropriate trace from the Plot Sensors Dialog

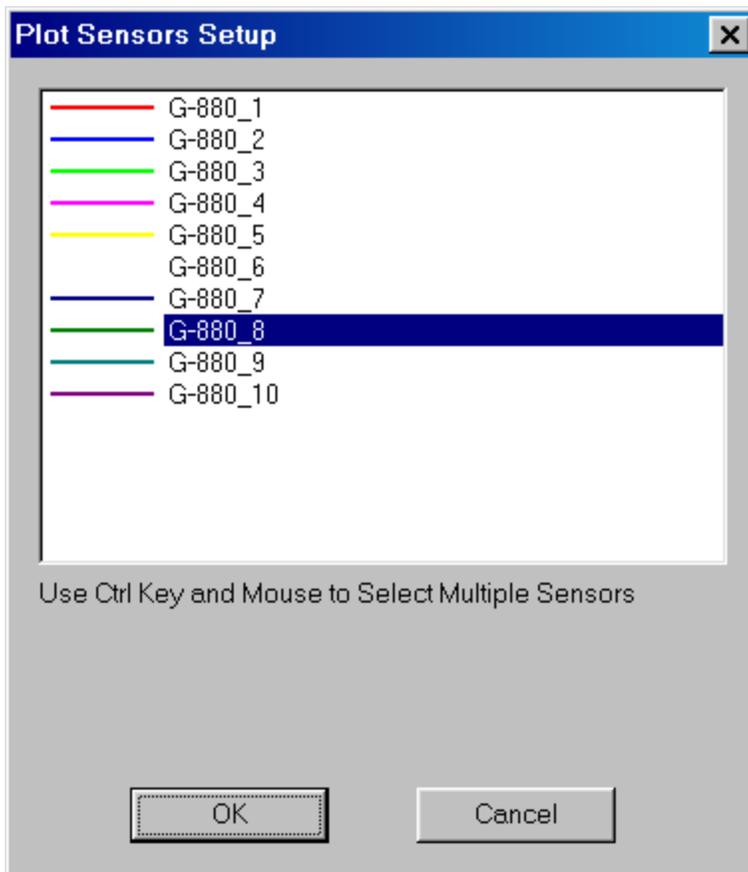


Figure 71

Here is an example of a trace chosen from the Plot Sensors Setup dialog.

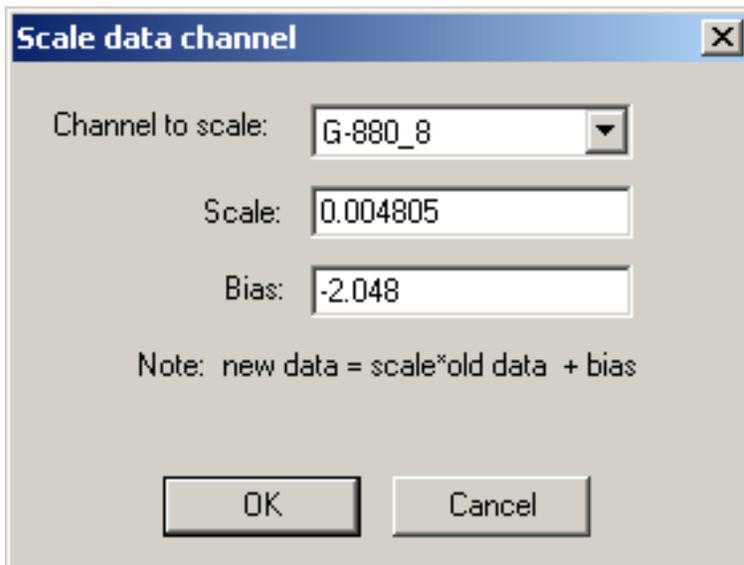


Figure 72

Next click on the Bias Setup menu item and choose the Scale data... item. You can enter Scale and Bias for the selected channel and click OK to apply the calibration.

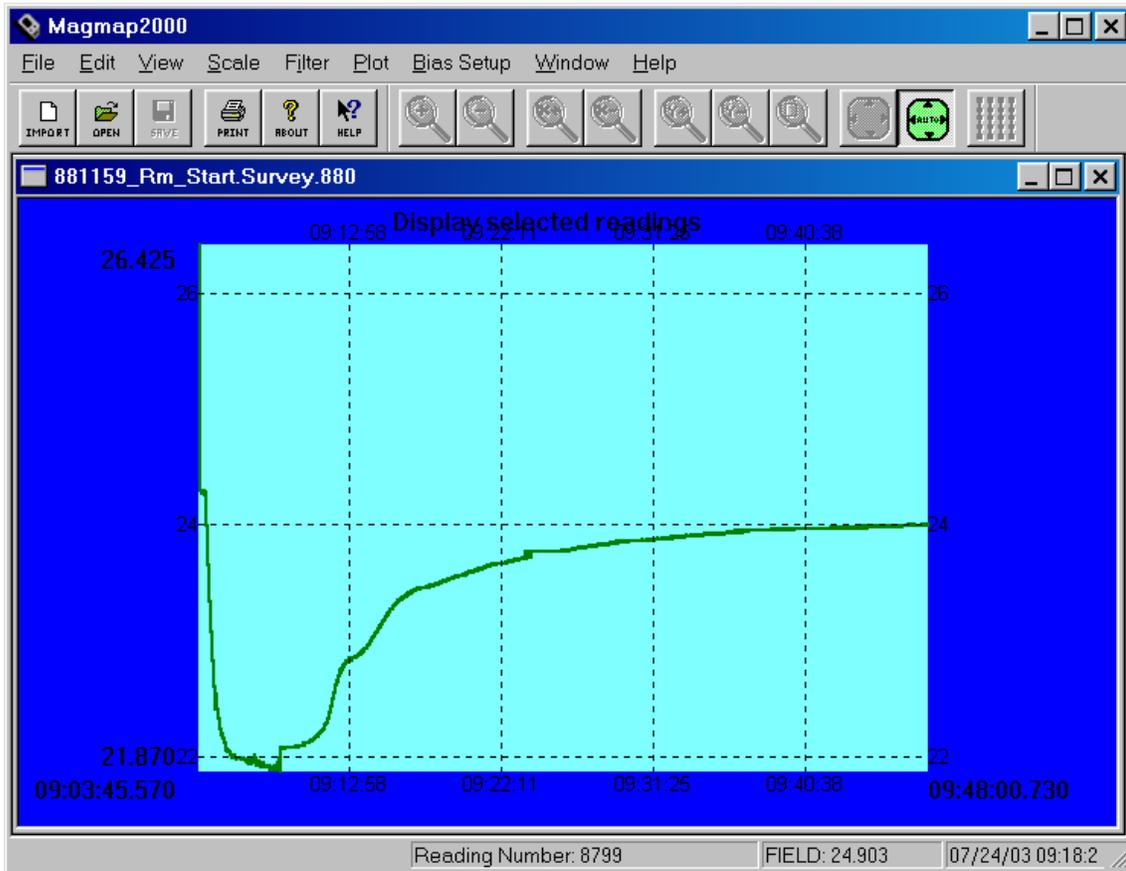


Figure 73

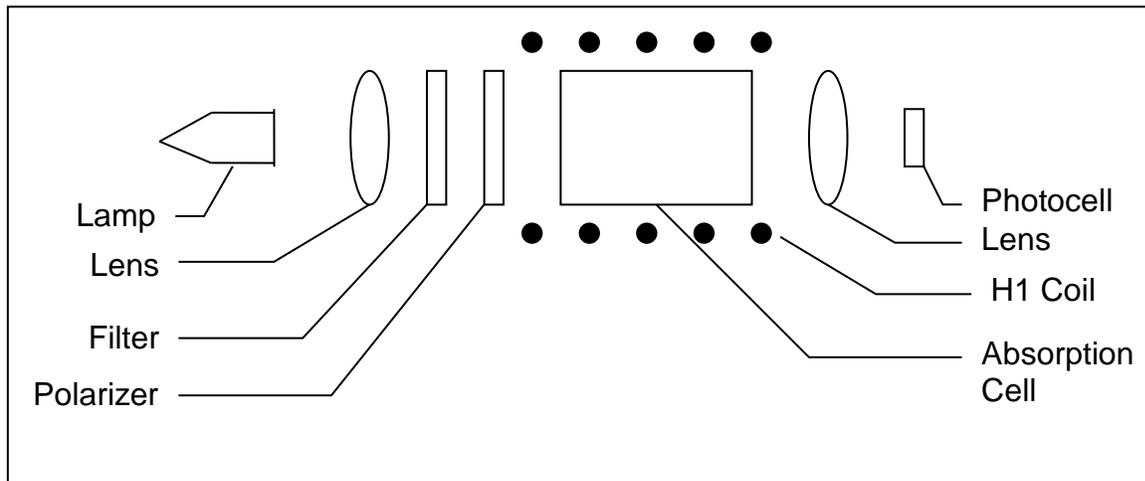
The data is now scaled in Volts DC.

NOTES

Appendix A – Optically Pumped Magnetometer Theory

Note: The following section is provided for information purposes only. Understanding this theoretical discussion is not required for proper operation of the magnetometer.

For purposes of this discussion, the ambient magnetic field or earth's magnetic field is called H_0 . A separate magnetic field generated by an AC signal applied to a coil inside the sensor is called H_1 . Refer to the drawing on the next page for the following discussion.



G-882 CESIUM SENSOR

To initiate operation of the sensor, the lamp oscillator's RF power increases until the lamp strikes (plasma ignites and fluoresces). The lamp oscillator then reduces its power to produce the regulated amount of light. The heater warms the absorption cell until a Cesium vapor is formed. A lens bends the light from the lamp to parallel rays. The lamp produces many spectral lines but only one line in the infrared region is employed. All of the other light is blocked by a high grade optical filter.

The infrared line of interest is then passed through a split-circular polarizer. On one side of the polarizer the transmitted light has an electrostatic vector that advances with a right-handed rotation. For conceptual purposes, it can be said that all of the photons in this light have the same right-hand spin direction. The light transmitted through the other side of the split-circular polarizer produces light in which the vector advances with a left-handed rotation, therefore having the opposite spin. Both circular polarized light beams pass through the absorption cell. Because there is a buffer gas in the cell, the single cell can be considered as two separate cells, each having the opposite sense polarized light passed through it. Both light beams exit the cell and pass to a second lens. This lens focuses the light onto an infrared photo-detector.

Because Cesium is an alkali metal, the outer most electron shell (orbit) has only one electron. It is the presence of this single electron that makes the Cesium atom well-suited for optical pumping and therefore magnetometry.

The Cesium atom has a **net magnetic dipole moment**. This net dipole moment, termed **F**, is the sum of the **nuclear dipole moment**, called **I**, and the **electron's angular momentum**, called **J**. In a Cesium atom:

$$I = 7/2$$

$$J = 1/2$$

and thus **F** can have two values depending on whether the electron's angular momentum adds to or subtracts from the nuclear dipole moment. Therefore, **F** can have the value of **3** or **4**. These values are called the hyperfine energy levels of the ground state of Cesium.

Normally the net dipole moments are randomly distributed about the direction (vector sum of the 3 axial components) of the ambient magnetic field (H_0). Any **misalignment** between the net atomic dipole moment and the ambient field vector causes the Cesium atom to be at a higher energy level than if the vectors were aligned. These small differences are called **Zeeman splitting** of the base energy level.

The laws of quantum electrodynamics limit the inhabitable atomic magnetic dipole orientations and therefore the atomic excitation energy to several discreet levels: 9 levels for the **F=4** state and 7 levels for the **F=3** state. *It is this variation in electron energy level state that is measured to compute the ambient magnetic field strength.*

When a photon of the infrared light strikes a Cesium atom in the absorption cell, it may be captured and drive the atom from its present energy level to a higher energy level. To be absorbed the photon must not only have the exact energy of the Cesium band gap (therefore the narrow IR line) but must also have the correct spin orientation for that atom.

There is a high probability that the atom will immediately decay back to the initial energy level but its original orientation to the ambient field is lost and it assumes a random orientation. An atom that returns to the base level aligned such that it can absorb another photon, will be driven back to the higher state. Alternately, if the atom returns to the base level with an orientation that does not allow it to absorb an incoming photon, then it will remain at that level and in that orientation. Atoms will be repeatedly driven to the higher state until they happen to fall into the orientation that cannot absorb a photon. Consequently, the circularly polarized light will depopulate either the aligned or inverse aligned energy states depending on the orientation (spin) of light polarization. Remember that one side of the cell is right-hand polarized and the other left-hand polarized to minimize sensor rotational light shifts and subsequent heading errors.

Once most of the Cesium atoms have absorbed photons and are in a state that does not allow them to absorb another photon, the light absorption of the cell is greatly reduced, i.e., more light hits the photo-detector. If an oscillating electromagnetic field of the correct radio frequency is introduced into the cell, the atoms will be driven back (depopulating the energy level) into an orientation that will allow them to absorb photons again. This frequency is called the Larmor frequency and is exactly proportional to the energy difference caused by the Zeeman splitting mentioned previously. This energy splitting is in turn directly proportional to the ambient magnetic field strength. The relationship between frequency and energy is given by:

$$E = f\hbar$$

Where:

E is the Zeeman energy difference

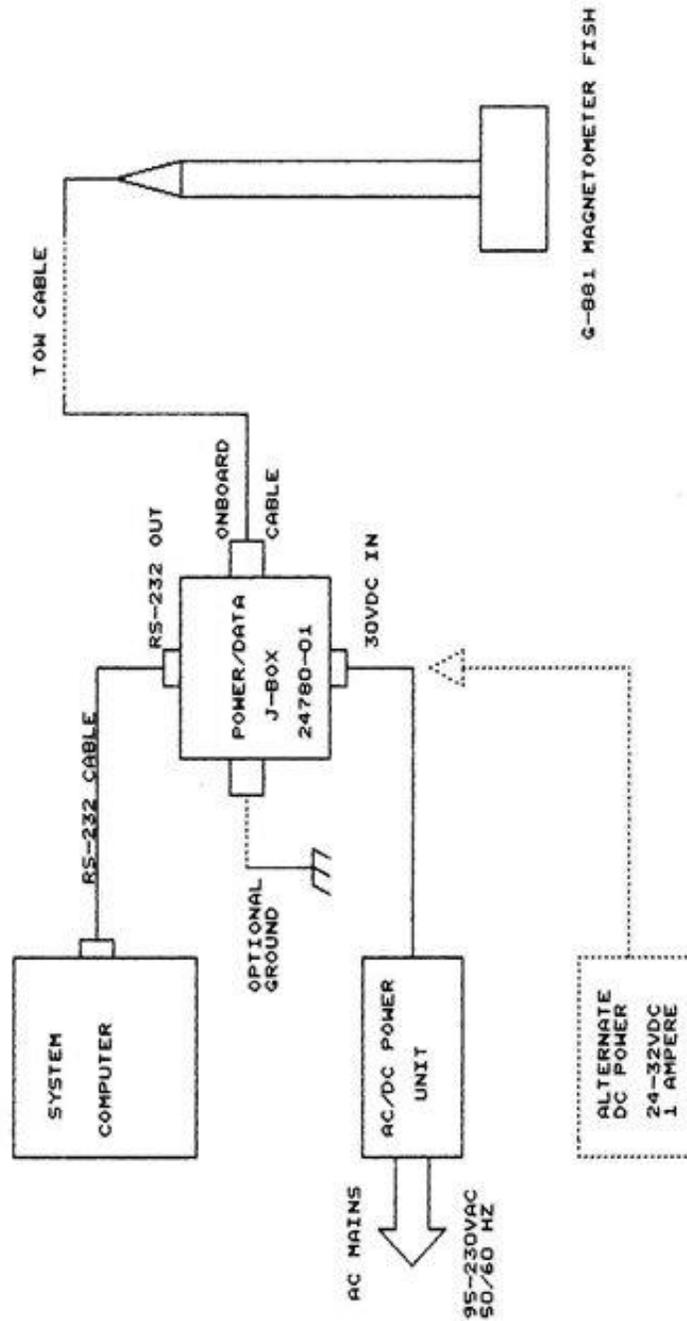
f is the frequency of the Larmor

\hbar is Planck's constant

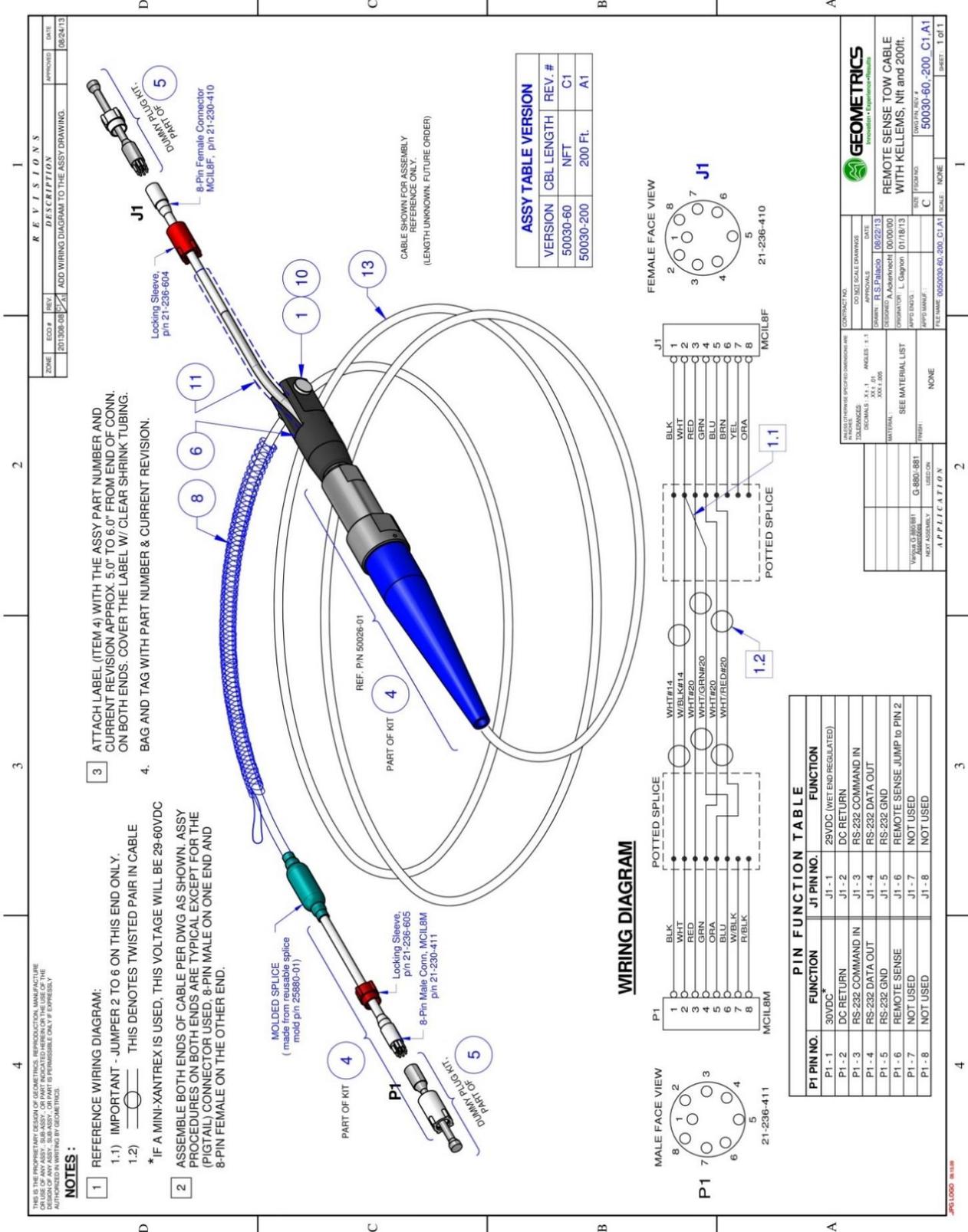
In Cesium this Larmor frequency is exactly 3.498572 times the ambient field measured in nanoteslas (gammas). In the G-882 this radio frequency field is generated by a coil, called the H1 coil, wound around the tube holding the optical components. When the RF field is present the total light passing through the cell is reduced because atoms are in an energy state in which they can again absorb the infrared light.

There is a small variation in the atomic light absorption at the frequency of the applied H1 depopulation signal. This variation in light intensity appears on the photo-detector as a small AC signal (microvolts). If this AC signal is amplified and shifted to the correct phase, it can be fed back to the H1 coil to produce a self-sustaining oscillation. In practice simply connecting the 90° phase shifted and amplified signal to the H1 coil will cause the oscillation to spontaneously start. Reversing the direction of the earth field vector (H_0) through the sensor requires the drive to the H1 coil to be inverted to obtain oscillation. (See Automatic Hemisphere Switching, section 2.4.3).

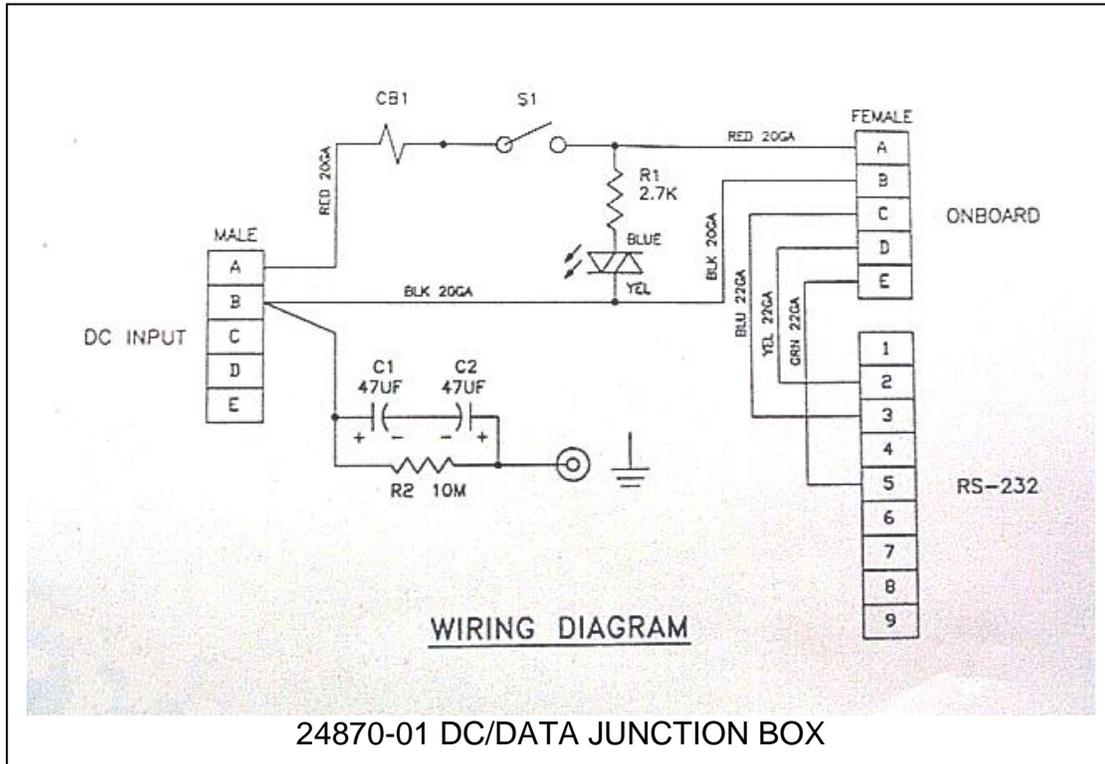
Appendix B – System Connection Wiring Diagrams

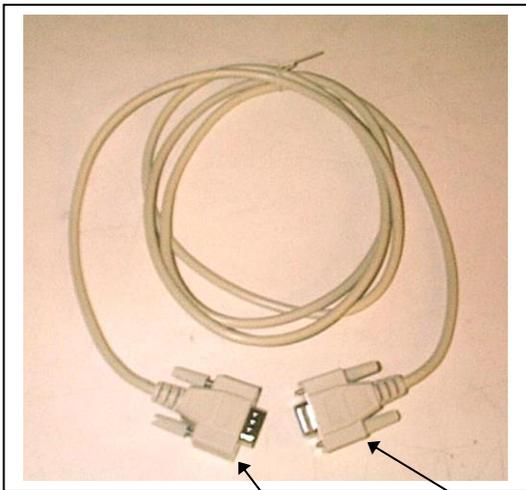
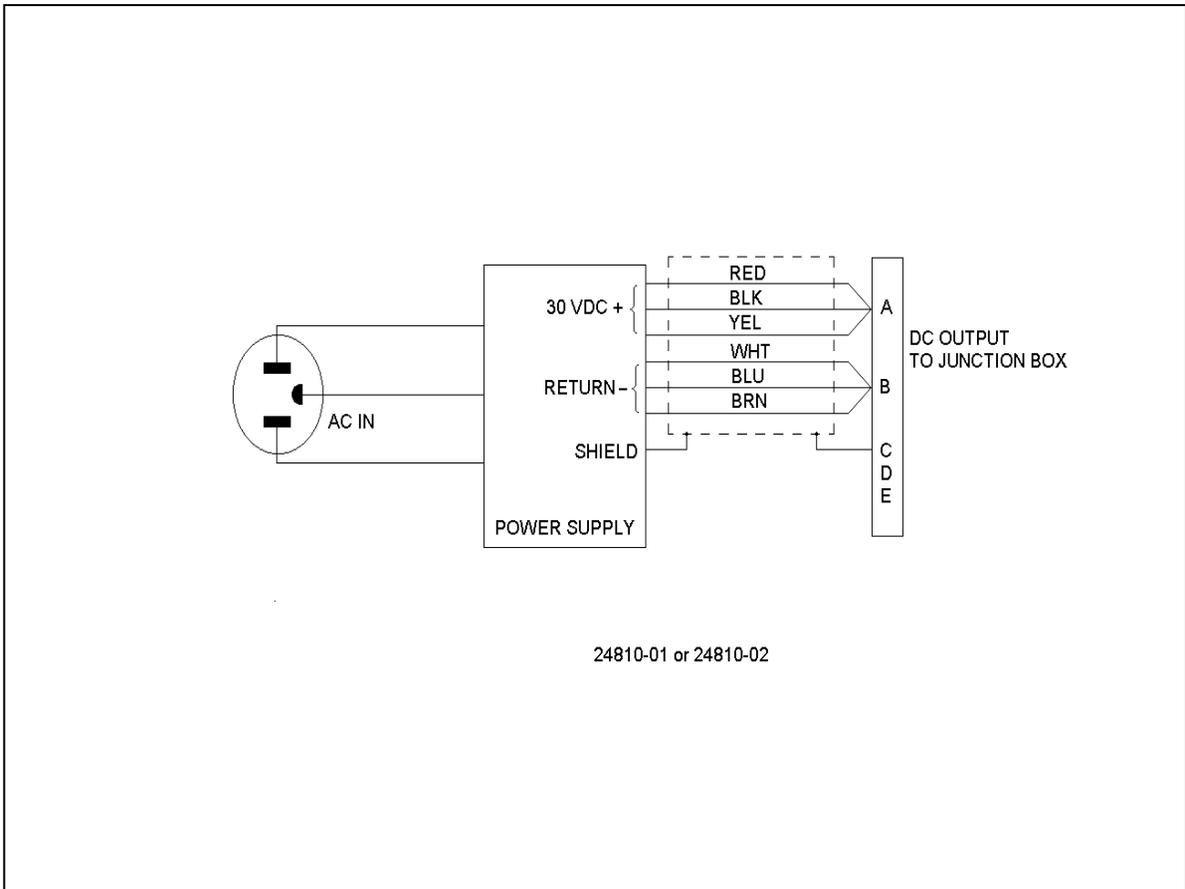


Tow Cable Wiring Diagram



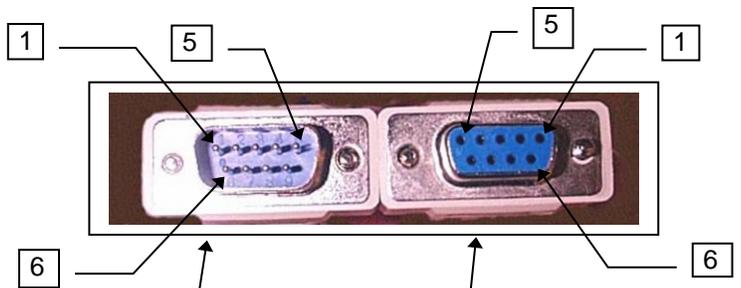
System Connection Diagram





SERIAL CABLE

Wired pin to pin, 1 to 1, 2 to 2, etc.



- Logging Computer
Serial Connector
Pin Out
- 1 DCD
 - 2 RX
 - 3 TX
 - 4 DTR
 - 5 Sig Gnd
 - 6 DSR
 - 7 RTS
 - 8 CTS
 - 9 RI

Connect to
the J-Box

Connect to
the logging
computer

Appendix C: G-882 with Larmor Output

If you did not purchase this special version of the G-882 magnetometer then the following does not apply.

This version of the G-882 Magnetometer is modified to provide the analog Larmor signal out a coaxial TNC connector at the white junction box so that it can be counted externally, as well as being internally counted and output via the serial port.

To get the analog Larmor signal from the magnetometer electronics to the outside world, a special tow cable is used to bring the Larmor signal to the white junction box through a coax cable inside the tow cable. In addition there is extra wiring added inside the G-882 fish and in the white junction box to pass the Larmor signal.

The G-882 is powered normally using a 28-volt supply through the white junction box. The serial magnetometer data (internally counted) is sent to the 9-pin connector on the white junction box as with a standard G-882. The only external differences on the system are the addition of the TNC analog Larmor output connector, a bigger connector (more pins) to interface the white box to the tow cable, and the special tow cable itself.

The analog Larmor signal is a sine wave whose frequency is proportional to the earth's magnetic field, and whose amplitude is related to the angle of the sensor axis to the earth's vector. The Larmor frequency is 3.498275 times the total field value. Thus for a 50,000 nT field the Larmor output frequency would be approximately 175 KHz. The amplitude of the Larmor signal is approximately 2 volts peak to peak at optimum orientation (sensor axis at 45 degrees to the earth's vector) and diminishing from there as the sensor is rotated toward either the polar or equatorial dead zones.

Unlike many magnetometer installations, the output Larmor signal is not superimposed on the DC power, nor can the magnetometer be powered through the TNC connector. The power to the magnetometer must be supplied through the power connector on the white junction box. The Larmor output is AC coupled through a 0.1uF capacitor inside the G-882.

At power up it is possible that a 28-volt positive transition may couple through to the TNC Larmor output connector. The input to the external counter should be protected against this transition (see the attached power/Larmor wiring diagram TD99873 for a system level look at how the Larmor signal is routed).

