

Minimising noise and interference - AX2000 & MC5 installation – May 2007

INTRODUCTION

Magnetometers can be successfully installed in almost any type of vessel with minimal intimidation from other electrical equipment, however a number of rules have to be obeyed and precautions taken.

Due to the high sensitivity of a proton magnetometer - enabling it to respond to signal levels of a few microvolts - there will always be a risk of interference from other electrical equipment and instrumentation. This document is intended to define the rules and detail the precautions to enable a successful installation & optimised performance to be achieved.

POWER SUPPLIES

The power supply for the magnetometer is the most common source of interference where this is not a totally independent supply devoted only to the magnetometer. A number of factors can combine to produce a high level of noise in the audio frequency range in which the magnetometer operates, these include: -

- A. Harmonics & voltage spikes from the charging system.
- B. Harmonics from power inverters - one of the worst offenders.
- C. Voltage spikes from pulsed instruments such as sonar & radar.
- D. Bilge pumps and other motors.

The answer is to provide the magnetometer with it's own battery supply of either 12v or 24v as appropriate. 12v is normally adequate if the magnetometer is supplied with a reasonably short towfish cable - up to 60m (200ft) - however in all cases a better signal to noise ratio is achieved with a 24v supply. 24v powering will provide a more aggressive polarisation of the protons in the towfish sensor with a corresponding higher returned signal level.

The battery system should consist of a single (12v) or series connected pair (24v) in a well-maintained condition with clean terminals for good low resistance connections. The size of the batteries is not the most important factor, however the minimum recommended size is 15A/H, this should be capable of supplying the magnetometer for an 8 hour survey period before requiring a full recharge.

MAGNETOMETER SEA EARTH

A magnetometer "Sea Earth" is a direct connection between the low side (-ve) of the isolated battery system and a metallic contact with the sea, this can be a Bronze or stainless steel strip attached to the hull below the waterline. The addition of a Sea Earth can sometimes be the final step to minimise any residual induced noise in the magnetometer system, however the improvement should be verified by checking the signal to noise ratio of the system, both with and without the Sea Earth attached. See the later section on checking signal to noise ratio.

NOISE VIA INTERFACES

Another point of entry for noise to get into the magnetometer system is via the PC & NMEA interface connections. The NMEA input has an internal opto-isolator providing full ground isolation; this eliminates ground noise except in very rare cases. The PC/laptop connection is a likely route for noise to get into the magnetometer, particularly when the PC is powered via a DC to AC inverter. Prior to 2003 models an external opto-isolator is provided with some models and is an optional extra with others, models supplied 2003 onwards have the opto-isolator fitted internally.

Noise elimination - Test methods

The following is a method of confirming the amount of noise being produced in the magnetometer:

MC5 - With a piece of steel such as a spanner taped centrally on the body of the towfish the signal is suppressed. Trail the tow-fish at a suitable distance behind the boat in an open sea area and observe the reading on the signal (small) meter. The observed readings should only be about 5 to 10% deflection. Rotate the Area Tune switch and see that a low meter deflection is observed over the whole range. If the displayed readings are higher than 10% then try re-routing the towfish cable to minimise any induction from ignition, generator or echo sounder transducer cables. In addition try the "Sea Earth" to see if an improvement (lower reading) is obtained - if so make this a permanent part of the installation. Having achieved the desired low noise result then the metallic object can be removed from the towfish; the standard tuning procedure can now be carried out to determine the optimum setting for the Area Tune Switch. Tuning should be carried out in an E/W or W/E direction where possible and give a deflection of between 60 to 95%. Once established this "area tune" selection will be appropriate within a 50-mile radius.

AX2000 – The above procedure is also valid for the AX2000 the only difference is that the tuning procedure is controlled by the menu and the results monitored on the graphical display.

General recommendations for optimum performance:-

1. Use a fully isolated dedicated 24V battery system.
2. Use a sea earth between the -ve (ground) of the magnetometer battery and the seawater - this is a stranded wire link attached to a stainless steel or bronze plate into the sea.
3. Avoid any mobile phones or VHF antenna close to the AX2000 receiver - this can cause spurious responses during each start of transmission.
5. Avoid traveling towards the equator (Due south in the Northern hemisphere) as this gives the worst signal level and increases vulnerability to noise.
6. Any unused towfish cable should be stowed in a figure 8 on deck to avoid noise induction.
7. Any inboard cable should be kept away from outboard/inboard alternators & Ignition systems.
8. Ensure that no additional metal items such as stainless steel shackles have been introduced on auxiliary towing lines at the towfish end of the cable.

Possible Cable Damage

If all the above recommendations have been followed and still a high level of noise persists on the magnetometer it is possible that damage to the insulation of the cable is the cause. Any leakage between the inner cores of the magnetometer cable and the seawater will induce noise into the signal path. In models with a secondary cable for depth of sensor monitoring the problem could exist in this cable or the main cable, try testing the magnetometer with the secondary cable disconnected at the rear of the magnetometer – if the problem disappears the insulation of the depth cable is likely to be damaged. Tests can be carried out to check the integrity of the cable insulation, using a multi-meter, the procedure is as follows:-

1. Attach a small piece of metal to one of the leads of a multi-meter to act as a submersible conductor, e.g. brass, stainless steel or copper.
2. Either prepare to submerge the cable directly into the sea or otherwise fill a plastic bin or tub with sea water or fresh water with sufficient salt to make it very conductive. The plastic container should be large enough to submerge the whole cable and tow-fish.
3. Place the lead with the conductive metal contact into the salt water and connect the other lead to the centre contact of the tow-fish connector.
4. Set the multi-meter to the highest M-ohm resistance range available.
5. Slowly immerse the tow-fish and cable into the salt water, monitoring the multi-meter reading continuously. Any sudden reduction in the reading – which should normally be completely open circuit or be at least be in the tens of M-ohms – will indicate a weakness in the insulation, it will also localize the problem.
6. The same test can be carried out with the depth cable where this is also included, if possible make contact with all three contacts in the depth connector or test with each in turn.
7. If any weakness is detected in the cable this will need remedial action, a short term solution may be to use insulation tape locally, however once salt water has entered the cable it should ideally be replaced as the cable will continue to deteriorate.

TESTING AN AX2000 MAGNETOMETER ON LAND

Where the performance of the magnetometer needs to be tested prior to going to sea or to check the noise and tuning performance, an effective test can be carried out on land.

The high sensitivity to field variations means that the magnetometer may only be used remote from known earth field disturbers, such as power lines or buildings. Before attempting to set up the magnetometer on land ensure that it is positioned at least 50 metres (160ft) from the nearest power line or building, additionally ensure that any vehicles are at least 10 metres (30ft) away.

Assuming the initial setting up is carried out on land the TOW-FISH should be positioned at least 3 metres (10 ft) from the electronics unit and battery. The tow-fish should be set up horizontally at least 1.25 metres (4 ft) off the ground using some form of totally non magnetic support - NOT EVEN CONTAINING SMALL NAILS, SCREWS OR EVEN STAPLES. Elevation of the sensor is very important unless carrying out the "land tuning" on totally magnetically clean ground.

Note although beach sand is generally magnetically clean this is not always guaranteed to be the case, if in doubt elevate the tow-fish as described above.