

# Fluxgate Magnetometers used for Onboard Closed Loop Degaussing

## Objectives

To provide real time data for mitigation of magnetic signatures of ships and submarines.

## Instrumentation

- Mag-03 precision three-axis magnetic field sensors
- Mag613 submersible eight three-axis magnetic field sensor array
- Custom designed magnetometers for specific requirements.

## Applications

- Increasing protection from mines for surface vessels
- Improving the 'stealth' features of submarines so as to avoid detection.

## Background

Degaussing is the process of removing magnetisation from an object by applying an opposing or alternating field to it. The most practical and controllable way to apply a degaussing field is by passing a current through sets of coils around the item of interest.

Warships and submarines are degaussed for a number of reasons. Ship degaussing was first carried out to reduce the threat of mines. Sea mines contain magnetic triggers; therefore a degaussed ship would have a smaller magnetic signature, reducing the chance of activating a mine. Submarines are degaussed as part of their broader range of discretion characteristics, for example to reduce the risk of detection from airborne MAD surveys.

Closed loop degaussing (CLDG) is the most comprehensive and effective method for degaussing a ship or submarine. The system is built into the vessel with sets of degaussing coils and magnetic field sensors surrounding the different compartments. It is called "closed loop" because the system defines the level of degaussing, measures the effects and feeds back alterations in real time.

CLDG has particular application for submarines as these are the more critical naval assets. Other than minesweepers, surface vessels are more likely to use a less intensive means of degaussing.

## Method

A CLDG system on a submarine takes advantage of the boat's two-hull structure. Submarines contain an inner and outer hull, usually made of steel. The inner hull contains all the crew compartments and is designed to



AN 0036 16/07

[www.bartington.com](http://www.bartington.com)

**Bartington**<sup>®</sup>  
Instruments

deal with the pressure demands on the vessel; the outer hull deals with hydrodynamics and control surfaces. With a CLDG system the coils and sensors are placed around the inner hull between the two hulls. This shields the sensors from the interference of stray magnetic fields from electronics and other sources inside the inner hull.

Coils are arranged in all three axes around the inner hull in sections. In each section of coils, 4-8 fluxgate sensors are positioned in a ring formation around the circumference of the inner hull. The three-axis fluxgates will give magnetic field readings in three dimensions, allowing accurate mapping of the magnetic field. The rings of sensors are separated equally along the length of the submarine to provide uniform coverage of the magnetic field. The greater the number of sensors, the more accurately the magnetic signature of the submarine can be measured.

The submarine's magnetic signature is modelled computationally and measured by the fluxgate sensors mounted on-board and on shored-based installations. With the initial signature calibrated, the appropriate degaussing currents for each section can be applied (different areas of the vessel will have larger or smaller signatures).

With the desired signature achieved, the magnetometers act as feedback sensors, capable of measuring nanoTesla variations caused by changes in depth or heading. The sensors can detect magnetic fields up to 3kHz, so rapid variations are fed into a central control system in real time and converted into the appropriate coil current to redress the balance. This maintains the reduced profile and avoids periods of a larger profile showing whilst the system reacts. Alternatively, lower frequency sensors, which have a strong immunity to the 50/60Hz interference that can come from on-board electronics, can also be used.

### References

Demilier L. et al, "Validation of Closed Loop Degaussing System for Double Hull Submarines", Marine System and Technology, Rome, Italy (2010)