

Application Note: Magnetic signature

OVERVIEW

Magnetics has been used for decades in military applications, especially in the maritime environment. Surface as well as underwater platforms are effectively a large mass of ferromagnetic material travelling within the Earth's field and as such will have both a remanent and induced magnetic signature. Magnetic influence mines were already used during WWII, and since there is a race to reduce the magnetic (as well as others) signature of a platform.

Additionally, the use of airborne magnetometers for the detection of submarines has made the requirement even more important to maintain the effect of surprise.

Thus, magnetic signatures are carefully measured as well as controlled via the use of non-magnetic materials, careful design, placement and on-board degaussing systems.

Fluxgate magnetometers for signature measurement

The first step of the process is to accurately measure the signature of the platform. Permanent signature ranges consist of an array of 3-axis vector magnetometers usually lined along the East-West and North-South directions. The array records the signature of the vessel whilst it is travelling North-South and East-West (this will give the two extreme signatures along the maximum and minimum horizontal Earth's field). The individual sensing elements of each sensor are also aligned to the best possible along the directions of travel.

The array will be installed at a depth similar to the expected depth of the threat, and generally accompanied by a pressure sensor to provide depth information.

Fluxgates are the best solution for this application as they are the most sensitive sensors easily deployed underwater. Within the Bartington's range of sensor, the Mag-13MSS or the Mag-03RC are the most suited. The Mag-03RC has the benefit of having the ability to be powered over long cables. Ranges need to be located in magnetically quiet environment away from harbor infrastructure.

Equipment

- Three-axis Fluxgate Magnetometer



Applications

- Measure the magnetic signature of military equipment from vessels and submarines to smaller equipment going on board these vessels.
- Measure and model the signature of scaled-models and test the behavior in a closed-loop degaussing (CLDG) system.

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Both sensors include a test function enabling check of the magnetometer's operation remotely. The Mag-13MSS does also include a temperature sensor.

These measurements are used to feed into on-board degaussing systems in order to ensure the best possible signature reduction. However, over the course of deployment the signature of the vessel can change. Checking it during operation has added benefit, and portable/deployable signature systems are used for this purpose. Here again the Mag-13MSS will be most beneficial as its reduced size makes it more easily handled.

Measurement of Scaled Models

In new vessel design or to test new systems, work is carried out on scaled models. This allow for the model to be positioned within a controlled field.

Due to the size constraints, a small sensor is required. The Mag613 is an array of 8 three-axis fluxgate sensors with each sensor head measuring 8x8x15mm. Each head is mounted on a 3m cable and the 64 outputs are multiplexed.

The sensors are generally positioned within the array and used to measure the signature in real time when testing degaussing systems such as Closed-Loop Degaussing System (CLDG).

This method uses distributed sensors throughout a platform measuring the magnetic signature in real time, with that information feeding back into the CLDG control system which will manage the current circulating within the degaussing coils. The Mag613, with its small size allows for its installation directly on board scaled models, which are the basis of new vessel design.

The use of fluxgate in on-board degaussing system

Once the measurement of the signature has been done, means of mitigating that signature are available. On-board degaussing uses magnetic data about the current location (from the world magnetic model, an on-board masthead magnetometer or an array of magnetometers) and the signature information to predict the signature of the vessel at a particular location. It is then fed back into the degaussing control system.

Bartington sensors are well suited as masthead magnetometer or for use as an array. Mag-13 will be the most versatile for this application.