THOMSON REUTERS
ENDNOTE

[Bhagat , 4(2): February 2017]

ISSN 2348 – 8034
Impact Factor- 4.022

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

DEGAUSSING SYSTEM

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ABSTRACT

Ships with a magnetic signature requirement are equipped with a degaussing systemto reduce their perceptibility for magnetic influence mines. To be able to reduce the magnetic

signature accurately, a proper distribution of coils over the ship is essential.Degaussing is the process of decreasing or eliminating a remnant magnetic field. It ispossibly named after the Gauss unit of magnetism, which in turn is named after CarlFriedrich Gauss. Due to magnetic hysteresis it is generally not possible to reduce a magneticfield completely to zero, so degaussing typically induces a very small field referredto as bias. Degaussing was originally applied to reduce ships magnetic signatures duringWWII.Ships with a magnetic signature requirement are equipped with a degaussing system to reduce their perceptibility for magnetic influence mines. To be able to reduce the magneticsignature accurately, a proper distribution of coils over the ship is essential.Degaussing system is basically used in navy.To nullify the ship's magnetic field with the help of:degaussing coils

***Keywords**: **Power** cabinet (POC) Command control unit (CCU)*

I. INTRODUCTION

Degaussing is the process of decreasing or eliminating a remnant magnetic field. It is named after the gauss, a unit of magnetism,Due to magnetic hysteresis, it is generally not possible to reduce a magnetic field completely to zero, so degaussing typically induces a very small "known" field referred to as bias.

Degaussing was originally applied to reduce ships' magnetic signatures during World War II. Degaussing is also used to reduce magnetic fields in cathode ray tube monitors and to destroy data held on magnetic storage.Until recently, the most common use of degaussing was in CRT-based TV sets and computer monitors. For example, many monitors use a metal plate near the front of the tube to guide the electron beams from the back. This plate, the shadow mask, can pick up strong external fields and from that point produce discoloration on the display.To minimize this, CRTs have a copper, or often in the case of cheaper appliances, aluminum, coil wrapped around the front of the display, known as the degaussing coil. Tubes without an internal coil can be degaussed using an external handheld version. Internal degaussing coils in CRTs are generally much weaker than external degaussing coils, since a better degaussing coil takes up more space. A degauss causes a magnetic field inside the tube to oscillate rapidly, with decreasing amplitude. This leaves the shadow mask with a small and somewhat randomized field, removing the discoloration.Many televisions and monitors automatically degauss their picture tube when switched on, before an image is displayed. The high current surge that takes place during this automatic degauss is the cause of an audible "thunk" or loud hum, which can be heard (and felt) when televisions and CRT computer monitors are switched on. Visually, this causes the image to shake dramatically for a short period of time. A degauss option is also usually available for manual selection in the operations menu in such appliances.

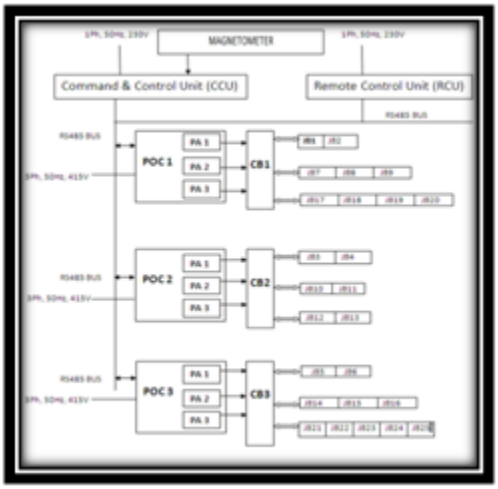
In most commercial equipment the current surge to the degaussing coil is regulated by a simple PTC thermistor device, which initially has a low resistance but quickly changes to a high resistance due to the heating effect of the current flow. Such devices are designed for a one-off

transition from cold to hot at power up, "experimenting" with the degauss effect by repeatedly switching the device on and off, may cause this component to fail. The effect will also be weaker, since the PTC will not have had time to

ISSN 2348 – 8034
Impact Factor- 4.022

cool off.Sea mines equipped with magnetic influence firing systems are effective and inexpensive underwater weapons. They are easy to deploy in large numbers against naval and commercial ship targets and constitute a formidable threat, both physically and psychologically. Thus effective measures for magnetic signature management are required to protect vessels against the threat from sea mines, fitted with modern magnetic influence firing systems.

II. METHOD & MATERIAL



Functional block diagram

Description of Components

Power Cabinet (POC)

The degaussing system consists of three numbers of POCs per ship, each one containing three PAs, isolation transformer, rectifier, filter and other required peripherals such as fuses, switches, etc. Each POC is fed from the 3 phases, 415V, and 50Hz supply of the ship. A step down transformer is used at the input of the rectifier unit in the POC. The input transformer provides isolation between the supply of the ship and the power amplifiers, and also facilitates the multi-pulse rectification to reduce harmonics on the input side. Each PA consists of a step down chopper (buck chopper), DSP based multi-loop controller, low frequency bridge and the filter circuit. Output current control is achieved through the closed loop control. The buck chopper is realized using semiconductors like Isolated Gate Bipolar Transistor (IGBT), diode and Silicon Controlled Rectifiers (SCRs) while the low frequency bridge uses SCRs. The buck chopper is fed from two dc supplies of -195V and -30V. The DSP based multi-loop controller of the PA continuously monitors output voltage, current, in-addition to current control and communication with CCU on the serial network.

In the automatic mode, PAs receives a current reference from the CCU on a serial link (RS485). PA is protected against output short circuit. In Manual mode, the current order has to be fed manually through Hand Held Terminal (HHT). This feature is useful for functioning of the system in case of failure of the communication network.

Power Amplifiers(PA)
Figure

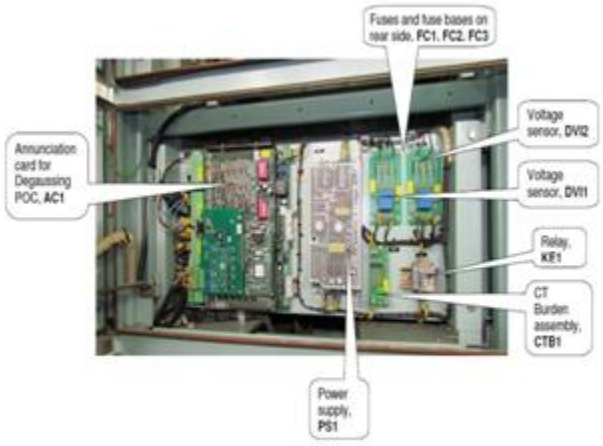


Figure 5 POC controller section

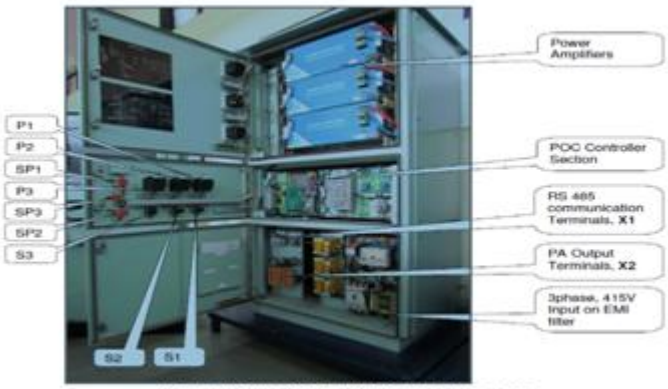


Figure 2 Power Cabinet (POC) with doors open

III. OTHER SECTIONS

Power Amplifiers(PA)
Each PA consists of a step down chopper (buck chopper), DSP based multi-loopcontroller, low frequency bridge and the filter circuit. Output current control isachieved through the closed loop control. The buck chopper is realized usingsemiconductors like Isolated Gate Bipolar Transistor (IGBT), diode and SiliconControlled Rectifiers (SCRs) while the low frequency bridge uses SCRs. The buckchopper is fed from two dc supplies of -195V and -30V generated in POC. The DSPbased multi-loop controller of the PA continuously monitors output voltage, current, in-addition to current control and communication with CCU on the full duplex RS485 serial network.

In the automatic mode, PAs receives a current reference from the CCU on a serial link. Manual mode is to be selected in case serial link between CCU and POC/Pas breakdown. The output currents to degauss the ship will be displayed after entering the Latitude, Longitude and Heading data in the software. These current reference values are to be fed manually through HHT in the respective PAs.

Command and Control Unit (CCU)

The CCU consists of a special computer, terminal server and alarm controller unit. The system software is loaded on Windows XP operating system. The terminal server facilitates connection of Navigation bus, Gyro, GPS, Magnetometer, POCs, PAs and RCU with the CCU. The alarm controller unit provides potential free contacts for integration of system with Integrated Power Management System (IPMS).
The functions of the CCU are

a) Setting the initial and ranging parameters of the equipment.
b) Turn ON and turn OFF the degaussing system.
c) Select the operating mode (Automatic, Manual or Stand-by).
d) Display system parameters.
e) Read the data from the ship's Navigation bus (roll, pitch, heading, latitude,
f) longitude).
g) Compute local components of the geomagnetic field.
h) Monitor and display the currents and health of each power amplifier.
i) Report the equipment warnings and alarms.
j) Entering the data in manual mode.

The software installed in the CCU performs the core operation, calibration and test function for the degaussing system. This software predicts earth's magnetic field based on latitude, longitude and time inputs. This prediction of earth's magnetic field from geomagnetic model is preferred to estimation based on a masthead magnetometer, for accuracy. The masthead magnetometer readings are likely to be inaccurate due to disturbance by ferromagnetic parts in its vicinity. The CCU gets latitude and longitude inputs from the ship's Navigation bus. The GPS and the Gyro are connected with CCU as a backup so that CCU continues to operate normally, incase it's communication with Navigation bus breaks down. During magnetic calibration, various permanent magnetization and induced magnetization coefficients are determined that best degauss the ship on any heading, roll or pitch angle or zone of operation. These coefficients are stored and utilized for determining current references for different PAs, in the CCU software. Protections for proper functioning of the equipment are provided in the degaussing equipment. The alarm and warning management is incorporated in the system. Potential free contacts are provided for integrating the system with IPMS.

Degaussing coils

To realize tri-axial degaussing, degaussing coils are laid in three axes of the ship. Based on the calculated amount of ampere-turns required to counter the magnetic field in the three directions at any time, current is injected in the respective coils. Six numbers of M coils are placed in the ship to counter the field in vertical direction. The vertical coil encircles the ship in a horizontal plane. M coils produce magnetic field that counteracts the ship's vertical permanent and induced magnetism. Ten numbers of L coils are placed in the ship to counter the field in longitudinal direction as shown in figure below. The longitudinal coil is made up of loops in vertical planes parallel to the ship's frames. L coils produce magnetic field that counteracts the ship's longitudinal permanent and induced magnetism. Nine numbers of A coils are placed in the ship to counter the field in athwartship direction as shown in figure below. The athwartship coil is made up of loops invertical fore-and-aft planes. A coils produce magneticfield that counteracts the ship's athwartshippermanent and induced magnetism.

Junction Boxes (JB)

The JBs are used to realize coils using nineteen core cables, laid in the ship's hull. The coils are formed by connecting different cores of a cable in series or parallel as per the coil current / ampere-turnrequirement in a junction box. There are twenty five JBs in the P28 tri-axial degaussing system, corresponding to the twenty five coils. Different "L" coils are connected in series depending on ampere-turns required to degauss the section of the ship and maximum permissible rating of the PA. In this system ten "L" coils are fed from four PAs, viz. PA2 housed in POC1, PA2 and PA3 housed in POC2 and PA2 housed in POC3.Similarly, "M" and "A" coils are also connected in series depending on ampere-turn required in respective sections of the ship and maximum permissible rating of the PA.

Connector Boxes (CB)

Connector boxes facilitate the series connections of coils and interconnection with POCs containing PAs. There are three CBs in the P28 tri-axial degaussing system, corresponding to the three POCs. Both the ends of degaussing coils are brought in the CB for series connection, e.g. both the ends of coils M1 and M2 are brought in CB1 for series connection. The series connection of the coils as described above is done in CBs mounted outside the POC. Two end connections of series connected coils in CB are terminated at respective POCterminals, e.g. one end of coil M1 and other end of coil M2 are terminated at the output of PA1 housed in POC1 through CB1.

Magnetometer and Data Acquisition Module (DAM)

ISSN 2348 – 8034
Impact Factor- 4.022

The magnetometer sensor provides measurement of static and alternating magnetic fields in three axes. The sensor, converts magnetic flux density, measured in three axes into a bipolar analog voltage. Analog output voltages Vx, Vy and Vz are in linear proportion to the flux density. This analog voltage data from sensor is converted into digital form in Data Acquisition Module (DAM) for communication with CCU on serial bus. The serial bus is optically isolated from output side to provide noise immunity. The tri-axial degaussing system utilizes magnetometer data for operation of the degaussing system in case of failure of Navigation bus, GPS and Gyro or when respective data ceases to be available to CCU. This happens in Stand-by mode of operation of the degaussing system. The magnetometer placed at the masthead senses existing magnetic fields in three axes and communicates this data (on serial bus) to the CCU through DAM. Based on this data, the CCU computes currents to be circulated in different coils to degauss the ship. The tri-axial magnetometer sensor employed in the system consists of three orthogonal double core second harmonic flux gate probes.

Remote Control Unit (RCU)

The RCU is a portable laptop with Windows XP operating system. The CCU / RCU software is installed on this laptop. The RCU is connected to CCU on full duplex RS485 network. The RCU facilitates remote control of the system, when "Remote Control" is selected in CCU. The CCU is required to be continuously ON to facilitate communication with sensors and peripherals used in degaussing system.

Compass Connection Box (CCB)

Compass Connection Box (CCB) facilitates extensions of signals, proportional to the coil currents in the vicinity of the compass, to the compass binnacle. This is required to compensate for the countering magnetic field created by degaussing coils. The coils M4, A3B(P) and L7 are in the vicinity of the magnetic compass. These coil currents affect the compass reading in absence of the compensation. The signals proportional to coil currents is brought from respective JBs to this CCB. The CCB facilitates signal conditioning such that voltage between 0.2 to 6V, proportional to coil current is applied to compass binnacle.

Hand Held Terminal (HHT)

Hand Held Terminal (HHT) facilitates entry of current reference to PA. HHT is used in the event of breakdown of communication network between CCU and POC / PAs.The HHT is a portable unit, which can be plugged onto port marked as "HHT" on PA. This derives power from a rechargeable battery.

IV. CONCLUSION

It is an essential system for reduction of magnetic field of the ship in order to protect the ship from magnetic mines

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