Magnetic Sensors And Magnetometers By Pavel Ripka

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Magnetic Sensors And Magnetometers By Pavel Ripka ***2021-02-12***

FRIDA MOORE

Giant Magnetoresistance (GMR) Sensors Artech House
The Final Proceedings for High Sensitivity Magnetometers Sensors and Applications: 4 - 8 November 2002. Magnetic sensors designed to operate both at room temperature and at cryogenic temperatures. Applications of these sensors will also be addressed including non-destructive evaluation of composite materials, magnetic anomaly detection, space magnetism, and geomagnetism.
Optimizing Nitrogen-vacancy Diamond Magnetic Sensors and Imagers for Broadband Sensitivity CRC Press
The main focus of this dissertation is investigation of vector AC Stark shifts (light shifts) in evacuated 133Cs paraffin-coated cells. Although light shifts in alkali atoms have been investigated since 1960s, the effect of laser-induced vector light shifts (VLS) in paraffin-coated cells is little explored in literature. The works considering light shift effects primarily focus on transitions relevant for atomic clocks, or magnetometers using buffer gas cells, or magnetometers using broad-spectrum alkali metal lamps. This work, on the other hand, focuses on light shifts in a setup shared by finite-field optical magnetometers that use paraffin-coated sensor cells, as well as on their impact on sensitivity and accuracy of these devices. Along with describing the light shifts, this work presents several techniques that take advantage of the VLS to improve atomic magnetometers as a tool. The proposed techniques eliminate the need for oscillating radio-frequency magnetic fields and replace them with well contained laser beams. This can benefit applications where non-magnetic sensors are needed and stray fields are highly undesirable, such as the search for a permanent electric dipole moment of the neutron. This dissertation includes two such projects, the all-optical vector magnetometer and the rf magnetometer driven by a fictitious magnetic field. In the first project a finite-field optical magnetometer, which is normally a scalar sensor, is augmented with two power-modulated orthogonal laser beams that provide the directional sensitivity. The sensor exhibits a demonstrated rms noise floor of 50 fT/√Hz in measurement of the field magnitude and 0.5 mrad/√Hz in the field direction. Elimination of technical noise would improve these sensitivities to 12 fT/√Hz and 5 [mu]rad/√Hz, respectively. In the second project, the atomic precession in a scalar 133Cs magnetometer is driven by an effective oscillating magnetic field provided by the AC Stark shift of an intensity-modulated laser beam. The demonstrated sensitivity of this magnetometer is 40 fT/√Hz rms, which is equivalent to the conventional coil-driven scalar magnetometer we built sharing the same setup. The Appendix includes documentation on the custom-built polarimeter used in the experiments and the frequency response of the magnetic sensor head.
Localization Using Magnetometers and Light Sensors Mdpi AG
This completely updated second edition of an Artech House classic covers industrial applications and space and biomedical applications of magnetic sensors and magnetometers. With the advancement of smart grids, renewable energy resources, and electric vehicles, the importance of electric current sensors increased, and the book has been updated to reflect these changes. Integrated fluxgate single-chip magnetometers are presented. GMR sensors in the automotive market, especially for end-of-shaft angular sensors, are included, as well as Linear TMR sensors. Vertical Hall sensors and sensors with integrated ferromagnetic concentrators are two competing technologies, which both brought 3-axial single-chip Hall ICs, are considered. Digital fluxgate magnetometers for both satellite and ground-based applications are discussed. All-optical resonant magnetometers, based on the Coherent Population Trapping effect, has reached approval in space, and is covered in this new edition of the book. Whether you're an expert or new to the field, this unique resource offers you a thorough overview of the principles and design of magnetic sensors and magnetometers, as well as guidance in applying specific devices in the real world. The book covers both multi-channel and gradiometric magnetometer systems, special problems such as crosstalk and crossfield sensitivity, and comparisons between different sensors and magnetometers with respect to various application areas. Miniaturization and the use of new materials in magnetic sensors are also discussed. A comprehensive list of references to journal articles, books, proceedings, and webpages helps you find additional information quickly.
Handbook of Magnetic Materials Morgan & Claypool Publishers
This book constitutes the refereed proceedings of the First International Workshop on Human Behavior Understanding, HBU 2010, a satellite workshop of the International Conference on Pattern Recognition in Istanbul, Turkey, on August 22, 2010. The 13 revised full papers presented were carefully reviewed and selected from 29 submissions. The papers are organized in topical sections on analysis of human activities; non-verbal action dynamics; visual action recognition; and social signals.
Vector AC Stark Shift in 133Cs Atomic Magnetometers with Antirelaraxion Coated Cells "O'Reilly Media, Inc."
This comprehensive new resource analyzes sources of noise and clutter that magnetic sensing system developers encounter. This book guides practitioners in designing and building low noise and low power consumption magnetic measurement systems. Various

examples of magnetic surveillance and survey systems are provided. This book enables system designers to obtain an all-inclusive spectral understanding of typical sources of noise and clutter present in the system and environment for each application, in order to successfully design stable and sensitive low power magnetic sensing devices. Detection and localization methods are explored, as well as deterministic and heuristics algorithms which are an integral part of any magnetic sensing system. This book is aimed to eliminate some of the "black magic" manipulations present during low noise magnetic measurements. The book meticulously describes, analyzes and quantifies the variables that affect low noise measurement systems. Readers are able to understand sources of measurements irregularities and how to effectively mitigate them. Moreover, this book also presents low power magnetometers and dedicated low noise sampling techniques.

Low-Power and High-Sensitivity Magnetic Sensors and Systems Artech House Remote Sensing Li

All fluxgate magnetometers are based on the theory of H.Aschenbrenner and G.Goubau developed in 1936 and the first fluxgates developed by F.Forster.Already the early satellites like putnik 3(Dolginov-Russia,1958), Mariner 4 (NASA/USA,1964), the first German satellite AZUR (Musmann, 1969) studying the magnetic fields of the Earth, Moon, Venus, Mars and other planets were using fluxgate magnetometers up to the latest NASA/ESA investigations on CASSINI (1998), and ESA's Rosetta(2004) and the first Ion Engine spacecraft\, NASA-DEEP-SPACE-ONE(Musmann/Kuhnke,1998), (see cover.) Very precise Earth magnetic field measurements in space have been made using fluxgate magnetometers in combination with scalar magnetometers (MAGSAT-Acuna,1979;OERSTED - Primdahl,1999;CHAMP-Luhr,2000) Only a few detailed descriptions about the theory and how to design and calibrate space fluxgate magnetometers and how to get reliable accurate magnetic field component measurements in space have been published.Therefore the worldwide small space fluxgate magnetometer community decided to document and save all their relevant know-how on space fluxgate magnetometers in this book before retiremen

A Procedure for Calibrating Magnetic Sensors Springer Science & Business Media

This completely updated second edition of an Artech House classic covers industrial applications and space and biomedical applications of magnetic sensors and magnetometers. With the advancement of smart grids, renewable energy resources, and electric vehicles, the importance of electric current sensors increased, and the book has been updated to reflect these changes. Integrated fluxgate single-chip magnetometers are presented. GMR sensors in the automotive market, especially for end-of-shaft angular sensors, are included, as well as Linear TMR sensors. Vertical Hall sensors and sensors with integrated ferromagnetic concentrators are two competing technologies, which both brought 3-axial single-chip Hall ICs, are considered. Digital fluxgate magnetometers for both satellite and ground-based applications are discussed. All-optical resonant magnetometes, based on the Coherent Population Trapping effect, has reached approval in space, and is covered in this new edition of the book. Whether you're an expert or new to the field, this unique resource offers you a thorough overview of the principles and design of magnetic sensors and magnetometers, as well as guidance in applying specific devices in the real world. The book covers both multi-channel and gradiometric magnetometer systems, special problems such as cross-talk and crossfield sensitivity, and comparisons between different sensors and magnetometers with respect to various application areas. Miniaturization and the use of new materials in magnetic sensors are also discussed. A comprehensive list of references to journal articles, books, proceedings and webpages helps you find additional information quickly.

Fluxgate Magnetometers for Space Research Springer

This book willbcof value to anyone who wishes to consider the use of SQUID-based magnetic sensing for anyone of a number of practical applications. The focus here is to examine in detail how SQUID technology is used and how. the results of the measurements obtained can be interpreted to provide useful information in a variety of real-world applications. The concentration is on those areas that have received the most attention, namely bioma~etism and nondestructive evaluation, but. the topics chosen include as well, geophysics, underwater ordnance detection, accelerometry and a few somewhat more exotic applications. To provide a reasonable perspective. an attempt has been made to consider competing technologies for most applications, and in some cases to consider how SQUID-based technology may be integrated with other technologies to provide an optimum total-system configuration. It is also the intention of the editor, that this book will be of major value to those scientists and engineers who will be required to build both the essential components and complete cryogenic SQUID systems which will be utilized in the various applications presented. Thus, there is a comprehensive review of the principles of SQUID operation, and a detailed exposition on the fabrication of high-temperature-superconducting (HTS) SQUIDs. Although the market is currently dominated by low-temperature superconducting (L TS) SQUIDs, it is reasonably certain that in the near future HTS SQUIDs will take over in most situations.

Hall Effect Devices, Second Edition John Wiley & Sons

This book presents in-depth coverage of magnetic sensors in industrial applications. It is divided into three sections: devices and technology for magnetic sensing, industrial applications (automotive, navigation), and emerging applications. Topics include transmission speed sensor ICs, dynamic differential Hall ICs, chopped Hall switches, programmable linear output Hall sensors, low power Hall ICs, self-calibrating differential Hall ICs for wheel speed sensing, dynamic differential Hall ICs, uni- and bipolar Hall IC switches, chopped mono cell Hall ICs, and electromagnetic levitation.

Magnetic Sensors for Biomedical Applications CRC Press

This completely updated second edition of an Artech House classic covers industrial applications and space and biomedical applications of magnetic sensors and magnetometers. With the advancement of smart grids, renewable energy resources, and electric vehicles, the importance of electric current sensors increased, and the book has been updated to reflect these changes. Integrated fluxgate single-chip magnetometers are presented. GMR sensors in the automotive market, especially for end-of-shaft angular sensors, are included, as well as Linear TMR sensors. Vertical Hall sensors and sensors with integrated ferromagnetic concentrators are two competing technologies, which both brought 3-axial single-chip Hall ICs, are considered. Digital fluxgate magnetometers for both satellite and ground-based applications are discussed. All-optical resonant magnetometes, based on the Coherent Population Trapping effect, has reached approval in space, and is covered in this new

edition of the book. Whether you're an expert or new to the field, this unique resource offers you a thorough overview of the principles and design of magnetic sensors and magnetometers, as well as guidance in applying specific devices in the real world. The book covers both multi-channel and gradiometric magnetometer systems, special problems such as cross-talk and crossfield sensitivity, and comparisons between different sensors and magnetometers with respect to various application areas. Miniaturization and the use of new materials in magnetic sensors are also discussed. A comprehensive list of references to journal articles, books, proceedings and webpages helps you find additional information quickly.

First International Workshop, HBU 2010, Istanbul, Turkey, August 22, 2010, Proceedings Artech House Publishers

This completely updated second edition of an Artech House classic covers industrial applications and space and biomedical applications of magnetic sensors and magnetometers. With the advancement of smart grids, renewable energy resources, and electric vehicles, the importance of electric current sensors increased, and the book has been updated to reflect these changes. Integrated fluxgate single-chip magnetometers are presented. GMR sensors in the automotive market, especially for end-of-shaft angular sensors, are included, as well as Linear TMR sensors. Vertical Hall sensors and sensors with integrated ferromagnetic concentrators are two competing technologies, which both brought 3-axial single-chip Hall ICs, are considered. Digital fluxgate magnetometers for both satellite and ground-based applications are discussed. All-optical resonant magnetometes, based on the Coherent Population Trapping effect, has reached approval in space, and is covered in this new edition of the book. Whether you're an expert or new to the field, this unique resource offers you a thorough overview of the principles and design of magnetic sensors and magnetometers, as well as guidance in applying specific devices in the real world. The book covers both multi-channel and gradiometric magnetometer systems, special problems such as cross-talk and crossfield sensitivity, and comparisons between different sensors and magnetometers with respect to various application areas. Miniaturization and the use of new materials in magnetic sensors are also discussed. A comprehensive list of references to journal articles, books, proceedings and webpages helps you find additional information quickly.

Technologies and Applications Springer

This book gathers, for the first time, an overview of nearly all of the magnetic sensors that exist today. The book is offering the readers a thorough and comprehensive knowledge from basics to state-of-the-art and is therefore suitable for both beginners and experts. From the more common and popular AMR magnetometers and up to the recently developed NV center magnetometers, each chapter is describing a specific type of sensor and providing all the information that is necessary to understand the magnetometer behavior including theoretical background, noise model, materials, electronics, design and fabrication techniques, etc.

High Sensitivity Magnetometers John Wiley & Sons

This book presents in-depth coverage of magnetic sensors in industrial applications. It is divided into three sections: devices and technology for magnetic sensing, industrial applications (automotive, navigation), and emerging applications. Topics include transmission speed sensor ICs, dynamic differential Hall ICs, chopped Hall switches, programmable linear output Hall sensors, low power Hall ICs, self-calibrating differential Hall ICs for wheel speed sensing, dynamic differential Hall ICs, uni- and bipolar Hall IC switches, chopped mono cell Hall ICs, and electromagnetic levitation.

Computational Science and Technology BoD – Books on Demand

Since the discovery of the giant magnetoresistance (GMR) effect in 1988, spintronics has been presented as a new technology paradigm, awarded by the Nobel Prize in Physics in 2007. Initially used in read heads of hard disk drives, and while disputing a piece of the market to the flash memories, GMR devices have broadened their range of usage by growing towards magnetic field sensing applications in a huge range of scenarios. Potential applications at the time of the discovery have become real in the last two decades. Definitively, GMR was born to stand. In this sense, selected successful approaches of GMR based sensors in different applications: space, automotive, microelectronics, biotechnology ... are collected in the present book. While keeping a practical orientation, the fundamentals as well as the current trends and challenges of this technology are also analyzed. In this sense, state of the art contributions from academy and industry can be found through the contents. This book can be used by starting researchers, postgraduate students and multidisciplinary scientists in order to have a reference text in this topical fascinating field.

Hall Effect in Semiconductors and Magnetic Sensors Springer

A fully updated, easy-to-read guide on magnetic actuators and sensors The Second Edition of this must-have book for today's engineers includes the latest updates and advances in the field of magnetic actuators and sensors. Magnetic Actuators and Sensors emphasizes computer-aided design techniques—especially magnetic finite element analysis; offers many new sections on topics ranging from magnetic separators to spin valve sensors; and features numerous worked calculations, illustrations, and real-life applications. To aid readers in building solid, fundamental, theoretical background and design know-how, the book provides in-depth coverage in four parts: PART I: MAGNETICS Introduction Basic Electromagnetics Reluctance Method Finite-Element Method Magnetic Force Other Magnetic Performance Parameters PART II: ACTUATORS Magnetic Actuators Operated by Direct Current Magnetic Actuators Operated by Alternating Current Magnetic Actuator Transient Operation PART III: SENSORS Hall Effect and Magnetoresistive Sensors Other Magnetic Sensors PART IV: SYSTEMS Coil Design and Temperature Calculations Electromagnetic Compatibility Electromechanical Finite Elements Electromechanical Analysis Using Systems Models Coupled Electrohydraulic Analysis Using Systems Models With access to a support website containing downloadable software data files (including MATLAB® data files) for verifying design techniques and analytical methods, Magnetic Actuators and Sensors, Second Edition is an exemplary learning tool for practicing engineers and engineering students involved in the design and application of magnetic actuators and sensors.

Magnetic Sensors and Devices IGI Global

This dissertation describes micromechanical Lorentz force magnetic sensors for electronic compass applications. Recent development in commercially available MEMS accelerometers and gyroscopes has been focused on the reduction of size, power consumption and cost, which has led to the integration of a 3-axis accelerometer and 3-axis gyroscope on the same chip, known as the 6-axis combo sensor. The growing market of smartphone, tablet and wearable device drives the need for a 9-axis combo sensor, which adds a 3-axis magnetic sensor to the 6-axis combo sensor. However, previous approaches to 9-axis combo sensors have been complicated by two facts: (1) the commercially available magnetic sensors cannot be co-fabricated with MEMS inertial sensors, therefore increasing the size, cost and difficulty of calibration. (2) magnetic material is required for commercially available magnetic sensors, which introduces problems such as hysteresis and limited measurement range. Single-axis, dual-axis and tri-axis Lorentz force magnetic sensors are designed and fabricated using microfabrication processes which are fully-compatible with MEMS accelerometers and gyroscopes. The magnetic sensors are based on micromachined resonators, which use no magnetic materials and can be easily integrated with CMOS electronics. The single structure tri-axis magnetic sensor described in this work demonstrates 0.1° heading accuracy with 1 mW power consumption, which is estimated to be 10X better in SNR compared to existing commercially available compasses. The design trade-offs between size, performance, and cost are also explored. In order to improve stability over temperature and eliminate the need for an external frequency source, both AM and FM readout closed-loop magnetic sensors are investigated. AM readout magnetic sensors can be realized by applying a Lorentz force in-phase with velocity to an electrostatically excited MEMS oscillator. FM magnetometers can be realized either by using the Lorentz force to create axial tension on a MEMS resonator, thereby changing its resonant frequency, or by applying a Lorentz force in quadrature with velocity to an electrostatically excited MEMS oscillator. Analytical and experiment results of all three types of closed-loop magnetic sensors are compared and discussed in detail in terms of their magnetic field sensitivity, bandwidth, resolution, offset, and temperature sensitivity. To further reduce the offset and the drift induced by the electrostatic force, current chopping is investigated. The current chopping technique periodically switches the polarity of the sensitivity of the magnetic sensors, while the offset remains the same. The offset of the sensor is reduced from 25 mT to 31 [mu]T, which is 10 times better than the existing Hall-effect magnetic sensors. The long-term drift is also reduced by 120X.

Recent Trends on Electromagnetic Environmental Effects for Aeronautics and Space Applications Elsevier

'Sensors' is the first self-contained series to deal with the whole area of sensors. It describes general aspects, technical and physical fundamentals, construction, function, applications and developments of the various types of sensors. This volume presents for the first time a comprehensive description of magnetic sensors with special emphasis placed upon technical and scientific fundamentals. It provides important definitions and a unique overview of concepts, and the nature and principles of magnetic fields. General questions concerning all types of magnetic sensors, such as those pertaining to material, noise, etc. are treated. Each chapter contains physical and mathematical fundamentals and applied technical concepts. In addition, each chapter presents an outline of the most important applications, measurement ranges and accuracy of sensing etc. This volume is an indispensable reference work and text book for both specialists and newcomers, researcher and developers.

Magnetic Field Sensing Using Micromechanical Oscillators CRC Press

Lorentz force magnetic sensors based on micro-electromechanical system (MEMS) resonators, measuring the vector components of the magnetic field, have recently attracted substantial commercial interest in inertial navigation systems (INSs) and compasses for smartphones. Over the last decade, substantial research effort has focused on improving the magnetic field sensitivity and resolution of Lorentz force magnetic sensors relying on either amplitude modulation (AM) or frequency modulation (FM), however, they mostly suffer from narrow bandwidth and low scale factor temperature stability, and their bias instability is poor due to high offset in the sensor output, which precludes their use in INSs and compasses. In this thesis, both AM and FM Lorentz force magnetic sensors are investigated to solve each of the above-mentioned problems, where AM sensors are operated either off-resonance in open-loop or at resonance in closed-loop. The MEMS magnetic sensors studied in this work are based on either a single resonator or dual resonators. The experimental results presented here make the Lorentz force sensor compatible with INSs and navigation-grade compasses. In the first part of this study, a method for improving bandwidth and thermal stability of the scale factor is presented. The method is successfully demonstrated using two nominally-identical, resonator-based AM magnetometers: the first is operated off-resonance in open-loop to measure magnetic field, and the second is operated as a closed-loop oscillator to provide a frequency reference for Lorentz force generation. With the proposed method, the sensor’s temperature sensitivity is reduced by a factor of 24, and a wide bandwidth (38 Hz) that is independent of the sensor’s mechanical bandwidth (3.2 Hz) is achieved. However, it is observed that the open-loop AM sensor operating off-resonance suffers from poor bias instability that is found to be limited by offset-related 1/f (flicker) noise. The root cause of 1/f noise is demonstrated to be 1/f noise on the ac and dc bias voltages applied to the sensor, and the effects of 1/f noise sources on the sensor’s bias instability are explored. To reduce offset-related 1/f noise, an innovative method based on chopping the dc bias voltage applied to the resonator is described. Using the chopping method, the sensor’s bias instability is reduced from 27 nT to 7 nT (the best bias instability reported to date for a resonant MEMS magnetometer). The second part of this study focuses on closed-loop AM operation. A force-rebalanced Lorentz force magnetometer is demonstrated, which is the first demonstration of a three-axis magnetic field sensing oscillator incorporating force-rebalanced operation. The proposed force-rebalanced magnetometer shows significantly superior scale factor stability performance over temperature change and allows larger bandwidth compared to conventional closed-loop magnetometers. However, the force-rebalanced sensor is plagued by offset arising from the electrostatic force used to drive the sensor into resonance. Because the offset is strongly temperature-dependent, the sensor’s bias instability degrades in the presence of temperature variations. This problem is successfully solved by designing a dual-resonator magnetometer, having two identical resonators with opposing axes of field sensitivity. In the last part, sensor operation is demonstrated using quadrature FM (QFM) readout, where the field is measured by monitoring the change in oscillation frequency. It is theoretically and experimentally demonstrated that FM sensors potentially provide wide bandwidth and improved stability over temperature as compared to conventional AM sensors. However, their output stability is still poor due to the temperature dependence of the sensor’s resonant frequency. To solve this problem, a dual-resonator QFM magnetic sensor composed of a matched pair of differentially operated resonators on the same silicon die are developed. Experimental data show that a differential measurement scheme using the dual resonator

significantly improves the sensor’s bias instability.
MEMS Lorentz Force Magnetometers Springer Science & Business Media
Progress on the development of a device, the MEMS flux concentrator, for mitigating the problem of 1/f noise in magnetic sensors will be presented. The MEMS flux concentrator essentially eliminates the effect of 1/f noise by increasing the operating frequency of the sensor to a frequency region where 1/f noise is small. This is accomplished by putting flux concentrators on MEMS structures whose motion modulates the magnetic field at the position of the magnetic sensor. Depending on the sensor, mitigating the effect of 1/f noise will increase the sensitivity of magnetic sensors by one to three orders of magnitude. Combining the MEMS flux concentrator with magnetic tunnel junctions with MgO barriers should lead to low cost magnetic sensors that are able to detect 1 pT signals at 1 Hz.
Thin Film Magnetoresistive Sensors Magnetic Sensors and Magnetometers, Second Edition
Magnetic Sensors and Magnetometers, Second EditionArtech House