NPL

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Report on temperature range for deliverable 2.1.1 of the EMRP project MetMags

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2 EXECUTIVE SUMMARY

Consultation on the temperature range for the report of deliverable 2.1.1 of the EMRP MetMags project was held at the UK Magnetics Society seminar "Novel Magnetic Sensors" hosted by NPL on 12th January 2012. At this seminar a panel discussion was held at which the opinions of those attending were used as input to the temperature range. Additionally, third party work at NPL and letters of support from stakeholders were also used. The temperature range decided upon for the measurement of gain, linearity and DC offsets was – 55 °C to 125 °C.

3 INTRODUCTION

As part of deliverable 2.1.1 of the EMRP project MetMags (Metrology for Advanced Industrial Magnetics) a report on the temperature range of task 2.1. of WP2 "Magnetic Sensors Testing and Calibration" was required. In this document the stakeholder consultations that were held to determine this temperature range is presented.

4 PROJECT REQUIREMENTS

Below is text taken from the EMRP proposal for JRP – 11i.

Task 2.1: Calibration of magnetic sensors at operational temperatures (**NPL,** CMI, Bartington Instruments, Rutherford Appleton Laboratory) Start month 6, End month 24. Measurements on sensors until month 36.

The aim of this task is to establish traceable measurement methods to determine the temperature dependence of technologically significant sensor quantities such as gain, linearity, offsets and noise for operational temperatures in the range of – 40 °C to 100 °C.

Description of work: **This task will initially establish the scope of the measurement requirements (Deliverable 2.1.1) through widespread consultation with industrial users at a stakeholder event** held within the first 6 months. It will then be necessary to implement methods to control the temperature without interfering with the magnetic environment to perform the calibrations identified. Users will then be able to establish the required temperature coefficients with an uncertainty that meets their requirements. The project collaborators Rutherford Appleton Laboratory and Bartington Instruments Limited will provide expertise to this task.

Deliverable number	Deliverable description (Ensure it is stated clearly and is C-SMART*)	Lead Participant	Other Participants	Deliverable type	Delivery date
2.1.1	Report on the scope of the required temperature measurements.	NPL	All	Report	M6

5 CONSULTATION WITH STAKEHOLDERS

Information on the required temperature range was obtained from the stakeholders in the following ways:

1. Experience of individual NMI's from previous projects
2. Informal discussions with industry at seminars, project reviews, business meetings etc.
3. Letters of support for project and business proposals
4. Panel discussion at the UK Magnetics Society seminar "Novel Magnetic Sensors" held at NPL on January 12th 2012.

Numbers 3 and 4 are presented in this report.

The "Novel Magnetic Sensors" seminar of #4, was also an early dissemination activity of the EMRP projects MetMags. Five of the speakers at the seminar were from this project.

The programme for the UK Magnetics Society seminar "Novel Magnetic Sensors" is included in Appendix A.

The list of delegates attending the UK Magnetics Society seminar "Novel Magnetic Sensors" is included in Appendix B.

6 INPUT RECEIVED AT STAKEHOLDER EVENT ON 12TH JANUARY 2012 AT NPL

Summary of the comments received from the audience follows:

Olivier Masseglia From Bartington Instruments Ltd. informed the meeting that the upper limit should cover the 125 °C experienced during "down hole" measurements for the oil and gas industry.

Nick Rouse from Telcon Limited agreed that the "down hole" use of magnetic sensors required 125 °C.

Andrew Fittock from Vacuumschmelze stated that the minimum temperature should be the – 55 °C required by the Aerospace industry.

Olivier Masseglia From Bartington Instruments Ltd agreed with the – 55 °C.

Comments also received that 100 °C would cover automotive. The proposed range would also cover rail. Transport requirements are therefore covered by the proposed - 55 °C to 125 °C.

CMI who are a partner of WP2 of the EMRP MetMags project collaborate with the Czech Technical University (CTU) in Prague. CTU has established - 20°C to + 60 °C for DC offset measurements. The proposed range of - 55 °C to 125 °C covers this.

The temperature range - 55 °C to 125 °C meets these requirements.

7 ADDITIONAL STAKEHOLDER INPUT

Information received from ESA and SSTL.

7.1 ESA REQUIREMENT

In a letter of support for the MetMags project dated 4th October 2012, Laurent Trougnou from ESA highlighted the need for low magnetic field measurement capabilities:

"Magnetometry is an important aspect of space exploration. Magnetometers are flown on-board scientific spacecraft to study such phenomena as the complex plasma interactions between the solar wind and the Earth's magnetosphere, to retrieve information about the deep interior of planets, or to map the Earth's magnetic field with ever increasing resolution and accuracy.

The ground calibration of space magnetometers is an important step for the success of each space mission flying scientific magnetometers.

The development of cutting-edge ambient field cancellation systems, stable over periods of hours, the application of stable, accurate fields of controlled orientation and magnitude, and the development of best practice guides/standards to improve cross calibration between instruments calibrated in different facilities, are important aspects."

The temperature requirement for space related missions appears in the ESA Statement of Work "Compact Low Noise Magnetic Gradiometer" from which the following environmental information was obtained:

Operating temperature: 5ºC – 60ºC

Survival temperature: -40ºC – 60ºC (without need of recalibration or loss of performance)

Humidity: 0 - 60%, non-condensing

EMC: EN 61326-1 (Electrical equipment for measurement, control and laboratory use – EMC requirements)

The temperature range - 55 °C to 125 °C meets these requirements.

7.2 SSTL REQUIREMENT

In a letter of support for the MetMags project dated 1st October 2010 from Simon Fellowes from SSTL said:

"Surrey Satellite Technology Limited would like to be kept informed about progress on the project

"Metrology for Advanced Industrial Magnetics".

In particular we would be very interested in the ability to magnetically calibrate some of our equipment over a temperature range -40 °C to +100 °C. Our existing requirement of -25 °C to +55 °C would be covered by this. Once the facility is up and running please do contact us. I can think of at least three tests that we would like to conduct under these conditions, with time I believe more tests would appear.

Thanks for keeping us informed about pending progress with your test facilities."

The temperature range - 55 °C to 125 °C meets these requirements.

8 PARAMETERS REQUIRED

For the temperature range decided, the magnetic sensor parameters that need to be calibrated so that the magnetic field of interest can be determined are:

- Gain
- Linearity
- DC offsets
- Orthogonality
- AC field rejection

Of these, the first three are expected to have significant temperature coefficients.

Therefore, the calibration of gain, linearity and DC offsets will be established for a temperature range of - 55 °C to 125 °C.

9 SUMMARY

Following consultation with stakeholders, measurement capability will be established within the MetMags project partners for the calibration of gain, linearity and DC offset in the temperature range – 55 °C to 125 °C.

Appendix A

UK Magnetics Society

Grove Business Centre Grove Technology Park Wantage Oxfordshire OX12 9FA UK
tel: +44 (0) 1235 770652 fax: +44 (0) 1235 772295 email: jward@ukmagsoc.co.uk
www.ukmagsoc.org

one day seminar

Novel Magnetic Sensors

Thursday, 12 January 2012

at

National Physical Laboratory, Teddington, Middlesex

Industry's drive towards enhancing the capabilities of magnetic sensors presents a constant challenge to the underpinning researcher, which must therefore achieve an equivalent step change in performance. Furthermore, the testing, characterisation and calibration of such sensors must account for the ever-expanding range of technologies, applications and environments that sensors are required to reliably operate within. In recognition of this and to celebrate the beginning of the EC (EMRP) funded project entitled "Metrology for Advanced Industrial Magnetics", this one-day seminar will discuss current and future developments in magnetic sensor technology and the corresponding evolution of traceable measurements and validation tools required.

PROGRAMME

Chairman: Stuart Harmon, National Physical Laboratory

from 0900 REGISTRATION/COFFEE

1000 ***Welcome/Introduction***

1015 ***The MetMags Project: European Metrology for Magnetic Sensors***
Dr Hans Schumacher, Physikalisch-Technische Bundesanstalt, Germany

1045 ***Microwave Damping Measurement Methods for the Development of TMR and Spin Torque Sensors***
Massimo Pasquale, INRiM, Italy

1115 ***Metrology Based on the Spin-Dependent Hall Effect in Semi-Conductors***
Dr Elisa De Ranieri, Hitachi Cambridge Laboratory

1145 ***Towards the Numerical Modelling of Nanostructured Magnetic Field Sensors***
Alessandra Manzin, INRiM, Italy

1215 LUNCH

Chairman: Dr Hans Schumacher, Physikalisch-Technische Bundesanstalt, Germany

1345 ***So, You Need Reliable Magnetic Sensors You Can Use With Confidence? How the Facilities and Field Standards at NPL can help***
Dr Michael Hall, National Physical Laboratory

1415 ***Developing a Magnetic Gradiometer for Space Applications***
Dr Doug Griffin, Rutherford Appleton Laboratory

1445 ***Challenges in Designing Customised Fluxgate Magnetic Field Sensors***
Oliver Masséglia, Bartington Instruments Ltd

1515 ***Panel Discussion***
This informal Q & A session will give researchers, manufacturers and industrial end users an opportunity to discuss the scope of this and future EMRP projects with members of the Metrology for Advanced Industrial Magnetics group

Appendix B

UK Magnetics Society

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tel: +44 (0) 1235 770652 fax: +44 (0) 1235 772295 email: jward@ukmagsoc.co.uk
www.ukmagsoc.org

Novel Magnetic Sensors

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ATTENDEE LIST

Mr Ibukun Adewale	University of Newcastle upon Tyne, School of Elec, Elec & Comp Engineering
Mr Mohammed Alamin	University of Newcastle upon Tyne, School of Elec, Elec & Comp Engineering
Miss Carolina Calderon	Health Protection Agency
Mr Zhirui Chen	Aeristech Ltd
Dr Marco Coisson	INRiM, Italy
Dr Elisa De Ranieri	Hitachi Cambridge Laboratory
Dr Lev Dorosinsky	UME, Turkey
Mr Tony Drake	Consultant
Mr Andrew Fittock	Vacuumschmelze (UK and Ireland)
Dr Doug Griffin	Rutherford Appleton Laboratory
Dr Michael Hall	National Physical Laboratory
Mr Hamed Hamzehbahmani	Wolfson Centre for Magnetics, Cardiff University
Mr Stuart Harmon	National Physical Laboratory
Mr Richard How	Infolytica Europe
Dr Cedric Hugon	Oxford Instruments, Magnetic Resonance
Mr Michal Janosek	Czech Metrology Institute, Czech Republic
Mr Barry Joplin	QinetiQ Limited
Dr Olga Kazakova	National Physical Laboratory
Mr Anthony Lonsdale	Sensor Technology Ltd
Dr Alessandra Manzin	INRiM, Italy
Dr Oliver Messeglia	Bartington Instruments Ltd
Mr Vishal Panchal	National Physical Laboratory
Dr Massimo Pasquale	INRiM, Italy

Mr Ravish Rajkumar	National Physical Laboratory
Mr Chris Riley	Cobham Technical Services, Vector Fields Software
Mr Pavel Ripka	Czech Metrology Institute, Czech Republic
Mr Nick Rouse	Telcon Limited
Dr Hans Schumacher	Physikalisch-Technische Bundesanstalt, Germany
Dr Thomas Schurig	Physikalisch-Technische Bundesanstalt, Germany
Mr Thomas Shanahan	British Geological Survey
Dr Sybille Sievers	PTB, Germany
Mr Sam Smett	Sensor Technology Ltd
Dr Hugh Stanbury	Materials KTN - Powders
Dr Renata Styblikova	Czech Metrology Institute, Czech Republic
Mr Colin Tucker	Morganic
Mr Christopher Turbitt	British Geological Survey
Mr Steven Turner	National Physical Laboratory
Mr Ales Zikmund	Czech Metrology Institute, Czech Republic