FINAL ABSTRACT

CRADA TITLE: Miniature Transducers for Flight Test Unit Instrumentation – Magnetic Field Detector

CRADA NUMBER: LA98C10367.00

The objective of this project was to design, produce, and test a miniature magnetic field detector suitable for applications involving flight testing of LANL-designed components. This objective was accomplished within the allocated time and budget. As a result, LANL capability to verify the performance of LANL-designed components under flight conditions has been vastly enhanced.

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Submitted as: Final Report
CRADA LA98C10367.00

Los Alamos
NATIONAL LABORATORY

DISCLAIMER

Miniature Transducers for Flight Test Unit Instrumentation – Magnetic Field Detector

Final Report

CRADA Number: LA98C10367.00

A. Parties

The project is a relationship between Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, New Mexico 87545 and

Honeywell (formerly Allied Signal), Inc.
375 N. Lake St.
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B. Project Scope

The scope of this project included the designing, building, and testing miniature magnetic field detectors that could be applied to very confined spaces on a variety of test articles. The deliverable was an magnetic field detector that met the requirements on area, thickness, and lead wire diameter, along with the proper magnetic field magnitude and resolution detection characteristics. This project was completed on time, without any major changes to the original concept of the project.

C. Technical

An examination of the configurations and test needs of LANL components during flight test activities revealed that valuable information could be gained from using magnetic fields to monitor the motion of a number of these components that are inaccessible to direct contact. This concept consists of rigidly attaching a small, powerful permanent magnet to the surface of a desired component prior to assembly. After assembly, any movement of this component can be monitored by measuring the field from the attached magnet using an appropriate detector rigidly mounted some distance away. This type of motion monitoring has the advantage that it is relatively nonintrusive – component motion can be evaluated at a distance without direct mechanical contact with the component being examined.

This combination of magnet/magnetic field detector can also be used to measure gaps between two interfaces. Small magnets surrounded by ferromagnetic "field shapers" can be imbedded in the two interface surfaces. As these surfaces move with respect to each other, changes will occur in the magnetic field some distance away from the interface caused by the interaction between the fields of the two magnets. If this "distant" field value can be calibrated as a function of the gap between the interface surfaces, this technique can be used as a remote gap measuring device.

One problem encountered was the severely limited space for magnetic field detection instrumentation at the pertinent locations on these test articles – no commercially available detector transducers were sufficiently small to meet the space requirements. Specifically, a magnetic field detector was needed with the following specifications:

1. Triaxial field measurement capability in a single transducer
2. Sensor size: 10mm x 10mm x 1.5mm thick

3. 1.0mm cable thickness, 8mm cable width
4. Frequency response, DC to 100 kHz at 3 dB point
5. Noise level: 2 mV rms @ 100 kHz
6. Power: +/- 12 V @ >50 mA
7. Dynamic range: 0 - 5 V output/axis
8. Linearity: 0.05% of full scale (2.5 mV)
9. Output impedance: 200 Ohms
10. Linear magnetic range: 0 - 15 Gauss and 0 - 150 Gauss (two sensor types)
11. Accuracy: 0.5% over temperature range
12. Temperature range: -40 to 85°C
13. Sensitivity: 300 mV/Oe/axis for 0 – 15 Gauss, 30 mV/Oe/axis for 0 – 150 Gauss sensors
14. Mass: 25g with 18 inches of six conductor ribbon and 9 pin D connector

Three giant magnetoresistive (GMR) sensors, one for each field X, Y, or Z component, comprised the heart of this magnetic field detector. To achieve the range, sensitivity, and accuracy limits specified above, amplifier, trim, regulator, and associated electronics had to be co-located on the detector chip with the sensors. One primary challenge was arranging this circuitry on a chip of the specified size. Despite this challenge, six prototype instruments were delivered by the industrial partner within the appropriate time limits, and laboratory testing proceeded to determine if transducer performance was adequate to measure the desired component parameters during flight. During this testing, it was determined that originally less stringent specifications for noise level, range, and sensitivity had to be changed to the final values given above. Thus, some amplifier and voltage regulator component changes to the prototype instruments were needed to achieve these new specifications. Also, two devices are needed: the 0-15 Gauss detector for gap measurements, and the 0-150 Gauss detector for motion monitoring. However, with the implementation of these changes, the devices meet all measurement requirements, and the magnetic field detector is now ready for production. There are no unresolved issues remaining on this CRADA.

D. Partner Contributions

The industrial partner in this project, Honeywell (formerly Allied Signal), Inc., built all prototype instruments with the dimensional and response properties specified. Honeywell has many years experience in instrumentation design and applications, and is planning to offer these magnetic field detectors (or variants thereof) commercially. At present, preparations are being made for production of these sensors at the Vetronix Research Corporation in Auburn Hills, MI. LANL plans to purchase 5 production sensors for delivery in mid-December, 1999, for environmental testing and application to ground testing of a flight test unit in FY00-01.

E. Documents/Reference List (Do not send documents, only the list.)

None

F. Acknowledgment

Industrial Partner's signature on the final report indicates the following:

1) The Participant has reviewed the final report and concurs with the statements made therein;

2) The Participant agrees that any modifications or changes from the initial proposal were discussed and agreed to during the term of the project;
3) The Participant certifies that all reports either completed or in process are listed and all subject inventions and the associated intellectual property protection measures attributable to the project have been disclosed or are included on a list attached to this report;
4) The Participant certifies that proprietary information has been returned or destroyed by Los Alamos National Laboratory.

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