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SINTEF A20659 - Åpen

Rapport

HISVESTA
HIgh Stability VErtical SeparaTion Altimeter instruments

D6.4a Final publishable summary report

Forfatter(e)
Dag Ausen

SINTEF IKT
Instrumentering
2011-06-01

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SAMMENDRAG

HISVESTA is a specific targeted research project running under EU's 7th Framework Programme, theme 7 Transport, including Aeronautics. The project has developed and is demonstrating a new generation of altimetry module, suitable for fixed wing and rotary wing applications, which will give altitude accuracy capabilities significantly improved over those currently available today. A new Air Data Computer has been developed, significantly smaller, lighter and with better performance than existing products to a lower cost.

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GRADERING
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GRADERING DENNE SIDE
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SEVENTH FRAMEWORK
PROGRAMME

HISVESTA

HIgh Stability VErtical SeparaTion Altimeter instruments

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WP 6 Management

June 2011

Responsible: SINTEF, Norway
Contributions: Memscap AS, Norway

Date / Revision	2011-09-30 / Revision 2
Dissemination level:	PU = Public

Contract No:	213729 HISVESTA
Instrument:	Collaborative Project, Small or medium-scale focused research project
Research Area:	FP7-AAT-2007-RTD-1
Coordinator:	SINTEF, Norway

HISVESTA

HIgh Stability VErtical SeparaTion Altimeter instruments

HISVESTA is a specific targeted research project running under EU's 7th Framework Programme, theme 7 Transport (including Aeronautics). The project started in January 2009 and will run until June 2011.

The project is the next step in solving the remaining RTD challenges after the successful HASTAC[1] project in FP6. The project will develop a new generation of altimetry module, suitable for fixed wing and rotary wing applications, which will give altitude accuracy capabilities significantly improved over those currently available today. Air Data Computer and aircraft flight testing performed in the project will demonstrate the effectiveness of the performance improvement.

SINTEF (Norway) coordinates the project. Memscap AS (Norway), Microelectronica SA (Romania), Curtiss-Wright Controls Ltd (Penny & Giles Aerospace Ltd) (United Kingdom) and Ceramica Ingenua SRL (Romania) are project partners.

www.sintef.no/hisvesta

[1] FP6 project HASTAC: www.sintef.no/hastac

Revision history

Date	Version	Author	Comments
2011-05-23	0.1	Dag Ausen	1st draft
2011-06-27	1.0	Dag Ausen	Preliminary version to project review meeting
2011-09-30	2.0	Dag Ausen	Final version

Contents

MEMS technology reaches for the sky

Innovative sensor technology for altimetry and engine control applications

HISVESTA is a specific targeted research project running under EU's 7th Framework Programme, theme 7 Transport, including Aeronautics. The project has developed and is demonstrating a new generation of altimetry module, suitable for fixed wing and rotary wing applications, which will give altitude accuracy capabilities significantly improved over those currently available today. A new Air Data Computer has been developed, significantly smaller, lighter and with better performance than existing products to a lower cost.

HISVESTA's goals contribute to the promotion of real breakthroughs, based on scientific and technical excellence, long term innovation and new knowledge related to:

- On board technologies for prevention of controlled flight into terrain
- Technologies to enable a full and permanent automatic approach and landing in all weather
- On board technologies for in-flight and on-ground collision avoidance novel concepts
- Techniques enabling the development of improved aviation safety metrics.

A significant additional result from the project will be a prototype high temperature pressure transducer unit utilizing new technology and methods for thermal compensation, linearization and long term stability prediction. The developments in this project will bring the SME-company Memscap in the forefront of the avionic transducer suppliers, and the technology and the results will boost the possibilities for getting a significant market share of aerospace pressure products to Europe in FADECs (Full Authority Digital Engine Control Unit), cabin pressure control systems and other segments. A first generation of the new Pressure Transducer concept will be tested in next generation FADECs, incorporating higher temperature resistance, and pressure detection closer to the compressor stages in the engine. This should be able to demonstrate lower emission of CO_2 and NO_x and less fuel consumption when introduced on the jet engine. The project has developed a prototype pressure transducer for temperatures up to 170 °C, and a range of relevant pressure regimes.

Another major contribution from HISVESTA is the development of a RVSM compatible digital Air Data Computer based on the new Memscap silicon pressure transducer. This will allow for a long term stability improvement of minimum 50 % in altitude, which is absolutely essential in critical applications as rescue squad operations, police helicopter operations, medical evacuation and off-shore operations in windy and low-visibility conditions. This will meet the objectives of operations in low-visibility conditions, and reduce the risk of accidents in in-flight operations. In addition the accuracy of altitude control including both manual and auto pilot systems in the full range of 0-45.000 ft will be significantly improved. Studies and Height Monitoring activities performed by EuroControl and FAA prove that a certain percentage of the current RVSM approved aircraft fleet is operating outside the RVSM altitude tolerance limits.

The project has also performed volcanic ash testing of transducer and ADU modules and study effects of this in parallel with a large altimetry lab test evaluation program at the end of the project.

SINTEF (Norway) has coordinated the project with the SME-company Memscap AS (Norway) as the Technical coordinator, while Microelectronica SA (Romania), Curtiss-Wright Controls Ltd (Penny & Giles Aerospace Ltd) (United Kingdom) and Ceramica Ingenua SRL (Romania) have been project partners.

Project summary

The HISVESTA project was started in January 2009 and had 30 months duration. All partners have been dedicated to their own identified work packages and tasks, and the progress and results were close to original plans. Minor adjustments have been made in the plans and milestones to adapt and improve the interactions between WP's and work tasks.

A mid-term review meeting was held late June 2010. This meeting concluded with an updated Description of Work (DoW) document and a revised budget for the project. These adjustments have been implemented in a contract amendment. The formal acceptance of the amendment was received from the Commission late 2010. The WP5 activities were reduced to carry out altimeter lab-tests and a lab simulation test. As a replacement, some volcanic ash testing was included in the test set-up, as requested by the project officer. HISVESTA project was able to get volcanic ash from the volcano Eyafjallajokull in Iceland, in order to test actual ash that generated a lot of problems in the European airspace during spring 2010. As an overall summary, the pressure sensors developed and demonstrated in the HISVESTA project did not have a detectable signal change when subjected to volcanic ash, for altitude measurements. This was tested on sensor level and in Air Data Computer level.

In WP1, all planned processing tasks and deliveries related to SP83/SW383 sensor elements for all 8 pressure ranges have been done (250hPa, 500hPa, 1000hPa, 0,2MPa, 0,5MPa, 1MPa, 3MPa and 6MPa). Some additional work has been done to define a revised Vacuum Reference die for High pressure sensors above 10bar, as some reference dies collapsed during pressure testing in the lab.

The test results of SP83 in different pressure ranges show very promising results. The number of devices from each pressure range measured is not very high, however based on the results found, the project concludes with a high degree of confidence that the targets related to accuracy and long term stability (better than 100ppm/FS/year) are met. In addition, high yield figures were recorded in the electrical probing station and in the different assembly steps, which indicates good results also for final assembled sensors in larger volumes, when getting industrialized.

In parallel, the design work and process development have been carried out for the high temperature operation (170 °C) SW384/SP84 wafers. The theoretical evaluation led to the design of an isolated SOI-piezoresistive solution as the best alternative for a high temperature pressure sensing element. Sensing elements for 6 different pressure ranges were designed and processed in the SINTEF MiNalab wafer fab. Several packaging concepts have been looked at and tested including certain packaging at wafer level. The basic research for high temperature metallization was done, and some test wafers were processed to verify the long term performance of the metallization.

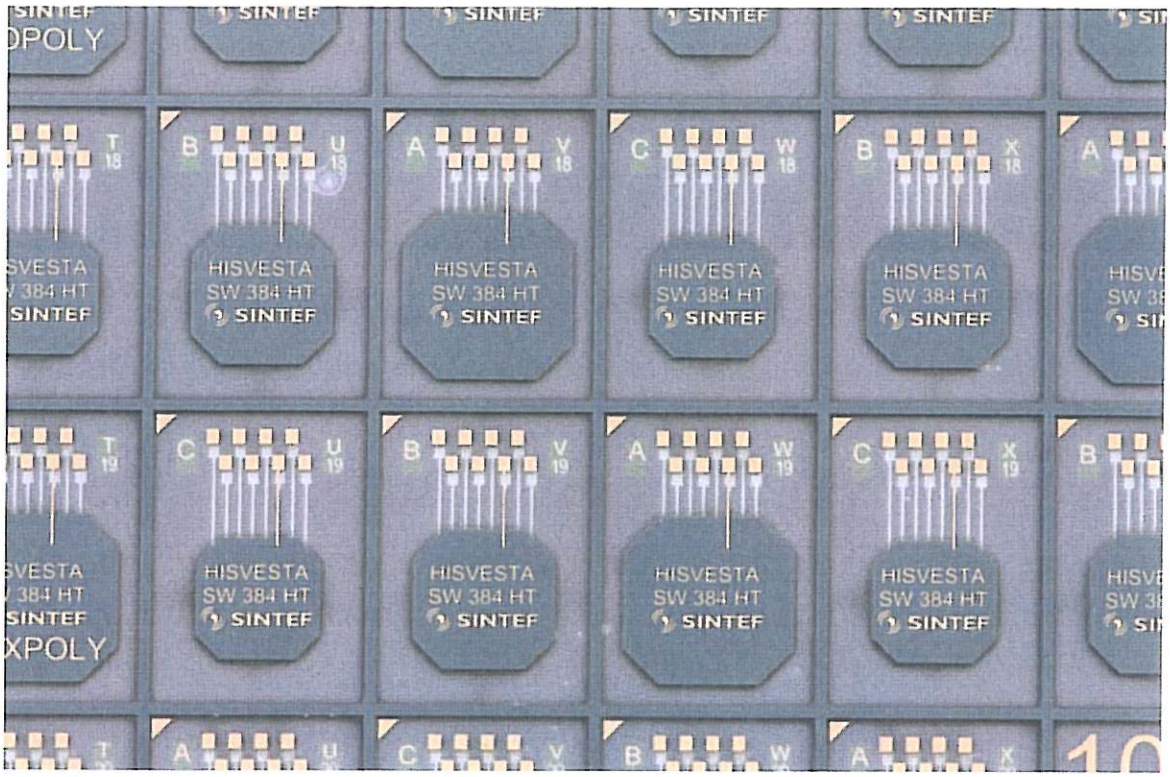

Figure 1 Final SW384 dies with Al-metallization

WP2 has worked on assembly of several batches of SP83/SW383 die/sensors in all 8 pressure ranges and packaging concepts for the high temperature SP84/SW384 sensor. Two solutions for improving the hermeticity of the TO8 header for SP83 are established which is very vital for Engine Control applications. Microelectronica, Ceramica and Memscap have contributed to this important progress. One concept is using a metallisation layer on the glass tube and to soft solder the glass tubes into TO8 headers. The other concept is using a metal tube in Invar, which is glass to metal compression sealed into the TO8 header. The soft soldered version is the solution selected for the parts in the project, however, more work will be done after the project closure, to identify the overall best performing solution.

In addition, major work has been but into the glass frit lamination process of the sensing dies, support dies and vacuum reference dies, where new technologies and equipments have been developed in the project. A more automated SST machine was utilized for assembling several hundred test structures during the project.

For SP84, the project has designed and developed a ceramic thick film based carrier substrate, where the sensing dies were mounted for characterization, and later used as test boards for determining the concept of interconnecting of both wire bonding and flip-chip the sensing element. A new pressure sensor prototype production line is ready in Microelectronica.

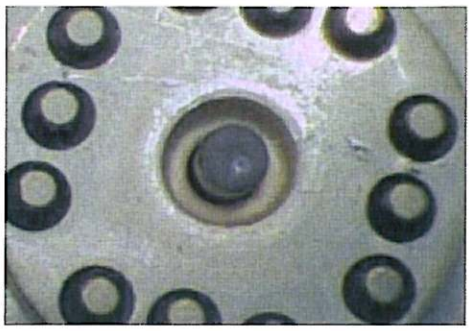

Figure 2 Soldered glass tube in TO8 header

WP3 has concluded the TP4000 design and optimization for higher speed, less noise and better accuracy in the Digital Pressure Transducer where the SP83 sensor is integrated as the core heart of the Transducer. A sample rate improvement from 20 to 2 ms was achieved. A number of prototypes with 2 A/D converters have been made and tested, and a batch of transducers was sent to P&G (Curtiss-Wright) for evaluation in their system testing. The results after several months of accelerated stress testing shows significant improvements in Long Term Stability performance compared to previous generations of Pressure Transducers. Component FMEA work was completed and documented. Concept design was made also for TP4100(RS485 interface) and TP4200 (heated mode sensing element), and hardware has been built and tested of the first units. TP5000 pressure transducer (using SP84 high temperature pressure sensing element) has concentrated on high temperature electronics and co-design of the high temperature sensing element. Significant work has been done in characterizing the different pressure ranges of SP83 sensors, sensor batches built for the project by Microelectronica in Romania. As a summary, all pressure ranges are within design specifications. However, important characteristics like thermal hysteresis and long term stability is not yet fully verified for all the pressure ranges, by the end of the project reporting period.

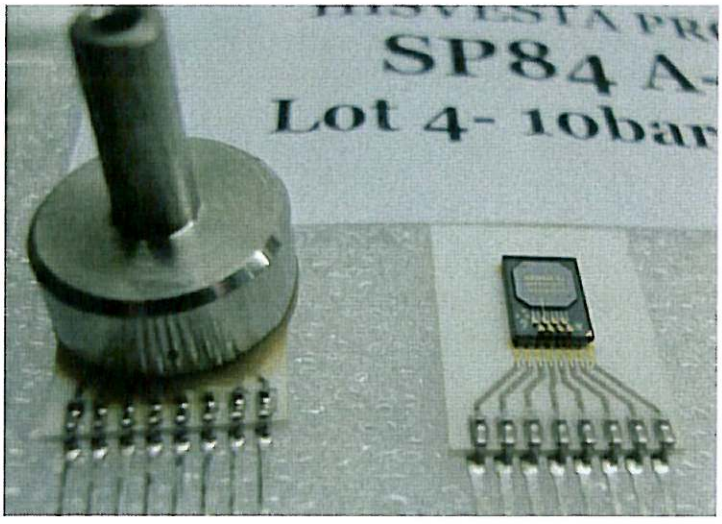

Figure 3 SP84 prototypes

In WP4, the design of the new miniaturized Air Data Computer electronics and electrical and mechanical interface have been designed, produced, assembled and tested. Testing and selection of microprocessor for the main board was completed about half way into the project.

Significant amount of work has been done in Transducer testing, both transducers supplied in the project but also external transducers for benchmark reasons. Automated Transducer test Equipment was designed and installed at Penny & Giles to prepare for high level of testing. Pressure transducers were received from two competing pressure sensor suppliers and from Memscap for the benchmarking test. Software plan, coding, test and verification were performed for the new ADU micro-processor. Processor performance testing has been completed, and has shown good throughput results. Non-qualified/non-certified prototype units of the new ADU have been demonstrated in project meetings, with impressive results. The pressure transducers developed in the HISVESTA project showed good performance, and is suitable for demanding RVSM applications then industrialized and put in the marketplace.

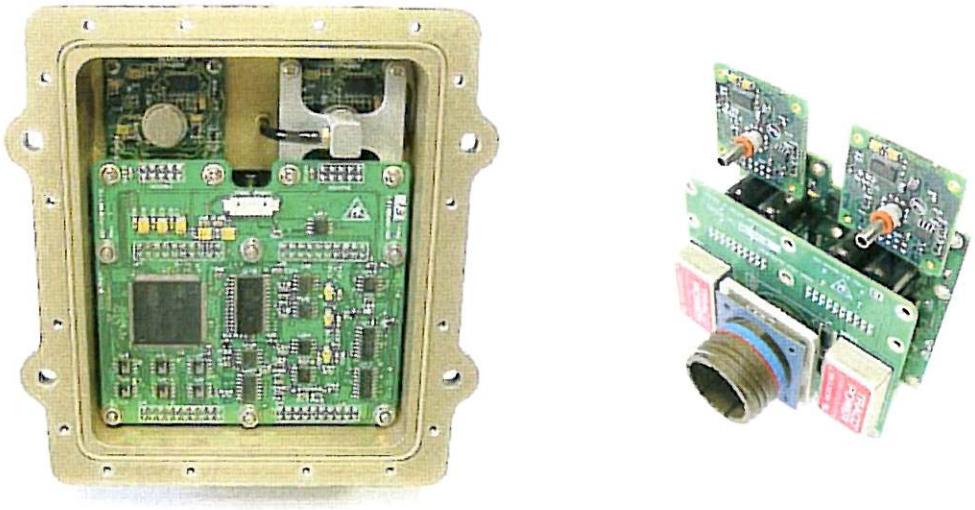

Figure 4 New digital Air Data Computer prototype

WP 5 (Flight test validation or Lab validation) was decided after the Mid Term meeting to be re-planned, as the cost for a real aircraft test flight evaluation was not justifiable from a price/value perspective. Additional Long term Lab tests and a specific volcanic ash testing were instead implemented in the last part of the project. The project was able to get hold of some kilos of actual volcanic ash from the last year active Eyjafjallajøkull in Iceland, that stopped or delayed the air traffic in Europe for several weeks. As the particles from the ground surrounding of the volcano are larger in size, the project had to grind the ash into different particle sizes for test purposes. To support the production of the correct and relevant particle size, photos of airborne particles that was detected on the west coast of Norway, was used as reference for particle size.

The HISVESTA project can for the entire project period document technical progress close to the original plans and that the main intentions and targets of the project have been met.

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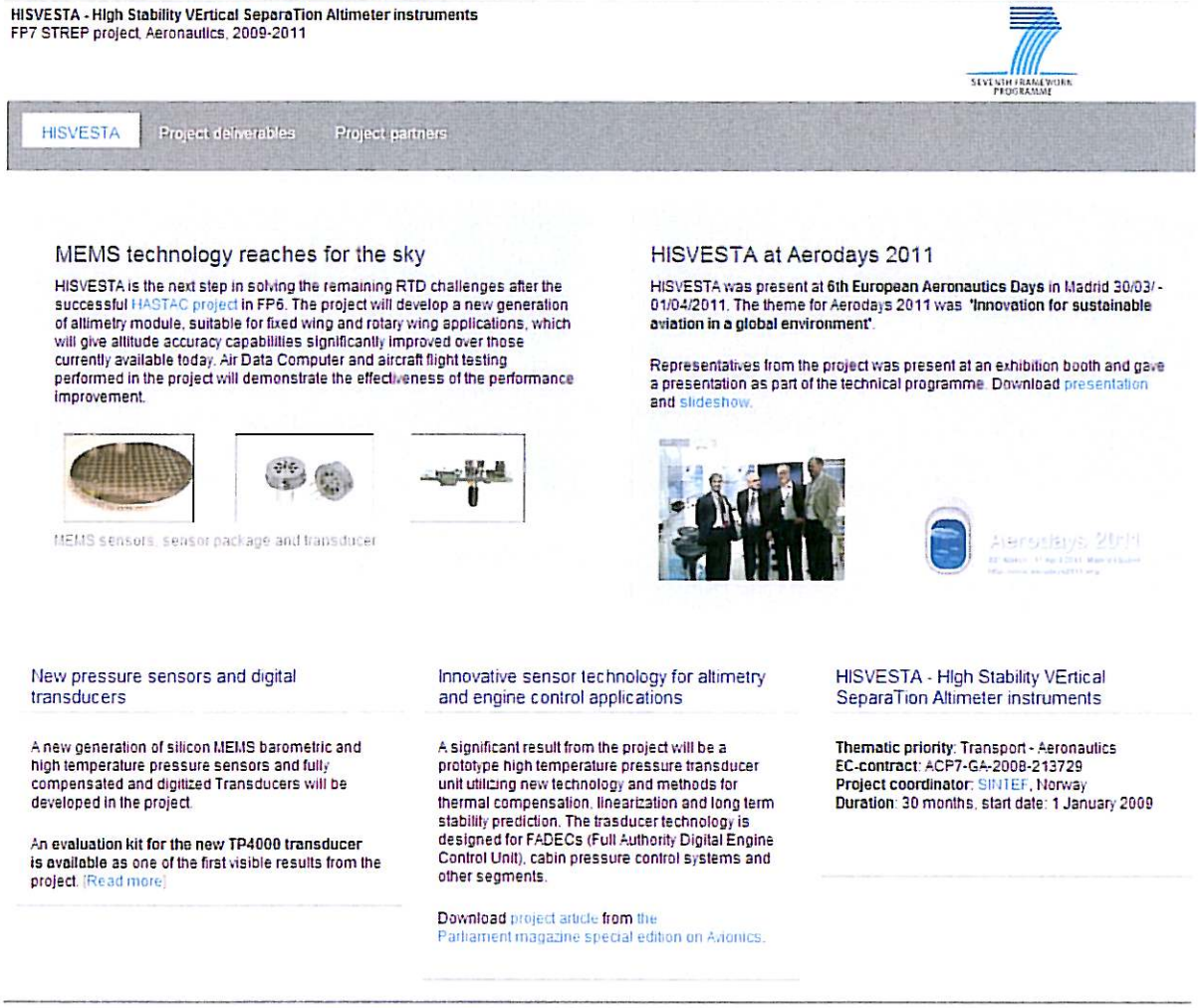
Publishable results from the project are available on the project web: www.sintef.no/hisvesta.



Updated project web-page (www.sintef.no/hisvesta)

Project beneficiaries

Stiftelsen SINTEF, Norway (coordinator) Dag Ausen (dag.ausen@sintef.no) Sigurd Moe (sigurd.moe@sintef.no) www.sintef.no	SINTEF is a multidisciplinary organisation structured into six business areas. The participating institute, Information and Communication Technology (ICT), is a centre for advanced and innovative research, development and advisory services in the fields of Microtechnology, Communication and software technology, Computational software, Information systems, Security and safety.
Memscap AS, Norway Ole-Henrik Gusland (ole-henrik.gusland@memscap.com) www.memscap.com	MEMSCAP AS is owned by the French MEMSCAP S.A. The business is focused on sensor- and transducer solutions, based on micro-electro-mechanical systems (MEMS) technology, for the Medical and the Aerospace industry.
Microelectronica S.A. (Romania) Liviu Jalba (www.microel.ro	Founded in 1984 as a MOS technology I.C.'s producer, MICROELECTRONICA has extended its field of excellence developing optoelectronic devices, special applications, new materials and devices.
Curtiss-Wright Controls (UK) Ltd. Stewart Bowen (stewart.bowen@pennyandgiles.com) www.pennyandgiles.com	Penny & Giles Aerospace, a part of Curtiss-Wright Controls (UK) Ltd. is a multidisciplinary organisation that designs, manufactures, repairs and supports avionics equipment, which incorporates electronics, software and mechanical elements.
Ceramica Ingenua SRL (Romania) Catalin Jalba (catalin.jalba@microel.ro)	Ceramica was established in September 2006 dedicated for ceramic composite materials and research activities in the field. The main business area is manufacturing and design of ceramic structures with supervised porosity and bio-compatible ceramic materials for bone reconstruction.