



IMPACT 2000

Technology Transfer Programme

I M P A C T

2 O O O

Materials



Computer Hardware & Software



Automation & Robotics



Sensors & Measuring Techniques



Mechanical Components



Precision Mechanics & Optics



Communications



Electronics & Opto-Electronics



Medical



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FOREWORD

■ The publication of this new edition of the ESA Technology Transfer Programme's catalogue "IMPACT 2000" is an ideal moment to take stock of the achievements of this initiative to promote the exploitation of space technologies in other industrial sectors. Over a period of eight years, we have described more than 350 technologies developed by European space companies in seven editions of our so-called "TEST" catalogue. More than eighty technology receivers have concluded transfer agreements with space-technology donors through the mediation of "SPACELINK". Among these examples are several that have opened up markets worth hundreds of MEuros for the companies involved.

Globally, the space sector is currently characterised by government-financed programmes that are stagnant or even shrinking. However, economic growth can still be realised for those space applications where satellites complement terrestrial technologies, especially in the areas of telecommunications and navigation. The cooperation of the space field with other terrestrial sectors through technology exchange is a key factor for the generation of new business opportunities to the mutual benefit of both space and non-space industries.

On the receiver side, the reuse of existing technologies and knowhow speeds up the process of new product introduction and the related purchase of technologies can be much cheaper than developing new technologies in house. The easier access to advanced technologies improves the competitiveness of the technology receivers, especially in the case of small- and medium-sized companies. At the same time, technology-transfer projects give non-space companies the opportunity to inject their own expertise into the space field.

Against this background, the promotion of technology and knowhow transfer represents a key element in the perception of our space activities as a service for a broad industrial community. I am confident that the technologies presented in this latest issue of the ESA technology-transfer catalogue, under the new name "IMPACT", can be an extremely valuable resource for supplementing the innovative potential of your company.

Pierre Brisson
Head of ESA's Technology Transfer Programme



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MATERIALS

SURFACE- ANALYSIS EXPERTISE

Description

Microanalysis of material surfaces is often a critical factor for successful space missions. Surface cleanliness is vital for performance and to minimise 'knock-on' effects such as the impact of out-gassing on spacecraft sensors and instrumentation. In non-space sectors, too, the importance of designing in correct material surface properties to ensure optimum performance and life is recognised worldwide. The chemical state of surface regions often controls other factors that are critical to product performance in areas such as semiconductors, adhesive strength, wettability, surfactancy, biocompatibility, colour, corrosion and wear resistance.

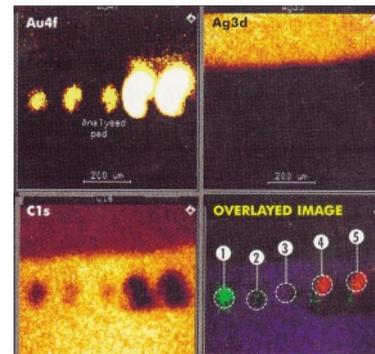
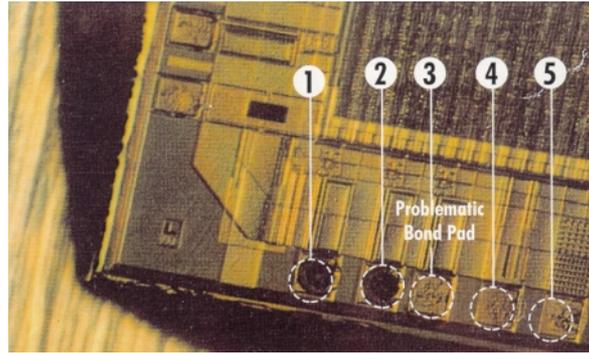
Methods and techniques for the surface analysis of outermost atomic layers include Secondary Ion Mass Spectrometry (SIMS), Auger Electron Spectroscopy (AES), X-ray Photoelectron Spectroscopy (XPS), and Laser Ionisation Mass Analysis (LIMA). These techniques are the most widely used for applied surface and depth-profiling analysis, giving very high elemental and molecular sensitivity.

SIMS analysis bombards the subject with a primary beam of ions or atoms and mass analyses the secondary beam ejected from the material. Interpretation of the resulting positive and negative ion mass spectra can provide detailed information about surface properties, including detailed molecular state information if required.

XPS and AES involves the analysis of the kinetic energy spectrum of bonding electrons that are ejected from the surface of atoms as a result of irradiation by X-rays. In both cases only those emitted electrons in the top 3-5 nm can escape from the sample for detection and thus only the properties of the top few layers of atoms are measured. These techniques can also be used for a deeper surface analysis; ion-beam-profiling can be used to remove successive molecular layers for analysis up to a depth of approximately 100 nm.

The latest generation of SIMS has been enhanced by the addition of time-of-flight measurements (ToF) and changes to the primary ion source. ToFSIMS, as it is known, can now provide resolving power in the order of $M/\Delta M$ (atomic mass units) = 10,000. Such resolving power has been available for some years in conventional mass spectrometers, but the high resolution of ToFSIM makes it possible to make such measurements directly at a sample surface.

For XPS, spatial resolutions of 50 μm can be achieved by using a small spot X-ray beam. By using a photoelectron microscope 5-10 μm spatial resolution can be obtained. Although resolution is lower for XPS than SIMS, other benefits can be obtained such as



achieving different oxidation states of the same element, quantification of surface composition and imaging to map surface coverage and determine surface composition from selected areas - neither of which are possible with SIMS or AES. XPS images are shown in the case study above to illustrate the benefits of this technique for identifying trace-level contaminants, which cannot be detected using conventional failure-analysis techniques.

Innovative Aspects

The assembly of 8 surface analysis instruments and complimentary equipment and expertise within one organisation make the service concerned almost unparalleled in Europe as a surface analysis test and advice facility. Several testing sites are available including two in the UK and one in The Netherlands.

Application Fields

Application areas include:

- Biocompatibility for biomedical implants
- Packaging
- Coatings
- Lubrication and wear
- Adhesion properties
- Colour
- Corrosion
- Surfactancy
- Photographic surfaces
- Semiconductors and electronics
- Wettability
- Surface contamination.

Status

Test equipment and expertise are available for use by space and non-space industry

Ref. 353



MINIATURISED INDIUM ION SOURCES

Description

Ion sources have found a range of applications in space technology in both the scientific and commercial domains. Their current scope of use, for example, ranges from mass spectrometry and spacecraft control, to electric propulsion. To satisfy the myriad of applications a miniaturised indium liquid metal ion source with variable current and lifetime capacity and “plug and play” type mechanical design has been developed. These ion sources were successfully tested in space for the first time back in 1991. To date over 1000 hours of flawless operation have been accumulated in orbit, on four different instruments. Present projects concentrate on the development and production of an electric propulsion system for ultra-precise spacecraft positioning and the development of a primary ion source for a time-of-flight mass spectrometer, in which a highly focused and isotropic pure indium pulse of 4 nanosecond is required in the search for organic materials in comet dust.

Liquid metal ion sources of this type exhibit very high current densities and can easily be focused to nanometre beam spots, while being mechanically very simple. Their high mass efficiency and low power consumption make them ideal candidates for use in space. Space operation further requires automated and untended functioning over years, robustness and relative inertness with respect to the ambient environment in order to avoid complicated spacecraft integration and testing procedures. All these properties of the ion sources are of equal importance when being employed in terrestrial industrial environments.

The standard indium ion emitter has a weight of about one gram and is typically 20 mm in length and 4 mm in diameter. This ion source can deliver a current of 15 μA during 3000 hours, and a maximum current of 500 μA can easily be drawn. For practical use the ion sources are integrated into so-called ion emitter modules which provide a protective housing, thermal insulation and electrical and mechanical interfaces. As an option, the module housing can be hermetically sealed for long-term storage under a protective gas atmosphere.

Storage at ambient atmosphere for a few days does not degrade emitter performance. The indium source is therefore easy to transport. Further, due to their modular and compact design the source is easy to mount on simple interface plates with just two screws. For operation only one high-voltage supply (0 – 10 kV, 0 – 500 μA) and a low-voltage supply (0-15 V, 0 – 60 mA) are necessary.

Innovative Aspects

Individual ion sources that are custom tailored for a specific application in respect to current and lifetime



requirements are assembled into a so-called standard module housing. This highly functional housing provides mechanical and electrical interfaces and also serves as transport container. The ease of handling the indium emitter is further enhanced by having the necessary heater element to liquefy the indium on ground potential, thus eliminating the need for bulky high-voltage transformers commonly used with this type of ion source. In applications with high duty cycles and low maintenance requirement, the modular plug-in design offers safe and reliable operation.

Application Fields

Ion beams produced by liquid metal ion sources can rather easily be focused to beam diameters of 20 nm at current densities of 10 A/cm² making this type of ion emitter a prime candidate in areas of focused ion beam applications. Material analysis, material microprocessing and ion beam lithography are the most prominent areas to mention. A complete material analysis station based on Secondary Ion Mass Spectrometry (SIMS) has been developed for the Russian space station MIR. This instrument can also be used as a transportable desk top instrument, for example, in the mining industry.

Status

Indium ion sources of the liquid metal type have been developed since the mid-eighties and are space qualified and space tested since 1991. Their robustness, reliability and ease of use has been demonstrated in 1000 operating hours in space and in extensive laboratory testing. The company is now seeking to extend the use of this technology to terrestrial applications in science and industry.

Ref. 354



NEW RANGE OF ELECTROMAGNETIC SHIELDING COATINGS

Description

The controls on electronic equipment emissions, or susceptibility to electromagnetic interference are now governed by new EC regulations. Compliance may be effectively achieved by using a metal shield coating.

Innovative Aspects

Developed for space purposes, a new range of conductive coatings provides effective screening from any electromagnetic disturbances. The types of resins used in the coating composition allow good adherence to any substrate and enables efficient screening for various devices of different sizes and shapes.

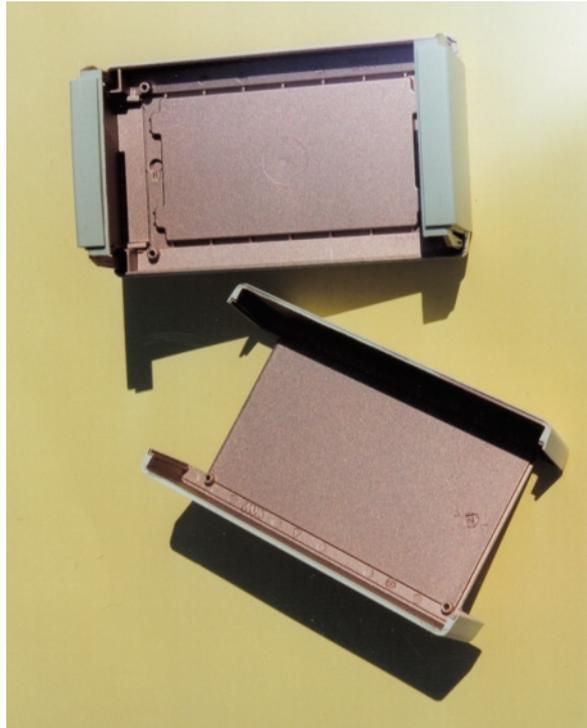
Application Fields

These coatings can be applied to dielectric materials use in mobile equipment and micro-computers, as well as on equipment used in the medical, scientific, military and automotive industries.

Status

The donor company proposes this new range of conductive coatings to customers, distributors and trading partners.

Ref. 355



NEW ANTISTATIC PAINTS PROVIDING ANTISTATIC PROTECTION AND RADIOTRANS Parency

Description

A new generation of antistatic paints for use on floors, which avoids the need to use metallic wire mesh, has been developed for space activities (launchers and satellites).

This coating can be usefully exploited in industrial environments where electrostatic discharges could cause damage to electronic equipment or pose a danger to health.

The antistatic system is achieved by applying the following composite structure to clevis cement or concrete :

- 1 coat of primer
- 1 bonding strap
- 1 antistatic black coat
- 2 coats of antistatic coloured top-coat
- 1 coat of antistatic enamel varnish.

Approved applicators and coating instructions are only available from the donor technology company.

Innovative Aspects

Special characteristics of the paints are:

- Prevents floors from accumulating electrostatic charges and ensures their discharge to earth.
- Glossy aspect.
- Paint is available in sand, light green, light grey, brown red.
- High chemical resistance (diluted acids and bases).
- High mechanical resistance.

Applications Fields

This coating can be used effectively to:

- eliminate the risk of fire and explosion in the manufacture of explosives, paints and other inflammable products
- enhance equipment reliability through effective discharge of electronic equipment and computers as used for example, in patient critical care
- safeguard humans against electric shocks due to electrostatic discharges.

Status

Collaborations and new applications are sought.

Ref. 356



COMPOSITE PRODUCTS: CFRP AND CMC

Description

The demand for structures with high strength and modulus, particularly when used in a high temperature environment, stimulated the development of carbon fibre reinforced plastics (CFRP) in the aerospace sector. In the case of CFRP-components, carbon fibres are used; these are available as rovings, fabrics or prepregs. As a matrix material, various plastics (thermoplastic or thermoset) as well as ceramics are used. Today, composites may be applied economically in many industrial areas.

There is a large and manifold field of application for CFRPs, especially for heavily loaded structural components in vehicles, for dynamically loaded parts in the engineering industry or for components used in high temperature environments. In mechanical engineering, CFRP-components are used as rollers for printing machines, rollers for paper cutting machines and guiding ways for linear robots.

We offer material selection and a manufacturing process (laminating, filament winding, tape-lay-up, RTM) specially tailored for each product. With the application of composite materials, the amount of material (and cost) can be optimized by designing the component according to its load distribution. The higher cost of carbon fibre per kilogramme compared to metals is offset by the lower consumption of material combined with its lower life-cycle-cost.

With the CFRP-Metal-Hybrid-Technique, an alternative method to realise full composite components, it is possible to reinforce metal structures with CFRP to enhance the performance of the corresponding products.

In Ceramic Matrix Composites (CMC), manufactured carbon fibre is impregnated with a special slurry composed of silicon polymers and ceramic fillers, then formed into a green body structure and cured by a normal autoclave cycle. After machining the parts, the subsequent pyrolysis of the CMC-structure is done at elevated temperatures (> 1000°C) without pressure and forming tools.

Innovative Aspects

The main advantages of these new materials are:

- high tensile strength, high stiffness
- low weight (reduced by 40-60% compared to metal)
- better dynamic features
- small thermal expansion
- high operation temperature
- no corrosion
- long life-cycle
- large-scale integration
- good design qualities



- partially lower tooling costs for series production.

Application Fields

- Bodywork (e.g. driver's cab for the new Mercedes Benz Unimog UX 100)
- Machine parts / drive units (e.g. drive shaft)
- Dynamically loaded supporting structures (e.g. robot arms, mechanical feeds for presses)
- Rollers (e.g. for printing machines, textile machines)
- Components designed for high temperature working (CMC: burner jet, furnace construction, parts in high-temperature processes).

Status

The company offers the following services:

- process or material development
- design and calculation
- prototyping and production.

Ref. 357



FORMATION AND DESTRUCTION OF DUST PARTICLE AGGLOMERATES IN PLASMA

Description

Work carried out in the study of space plasma has led to the understanding of the forces involved in the formation of dust particle agglomerates. This in turn has enabled the development of methods for the controlled formation and destruction of dust particle agglomerates. The techniques that are being developed can in theory substantially reduce the size and frequency of dust particle agglomerates in processes such as plasma etching and plasma coating. The importance of these results is evident in the light of the drive to keep reducing the size of components in silicon chips and the economic impact of rejection rates in the production process. Reducing the size and number of dust agglomerates would contribute to a fall in the number of chips damaged by bridging of features. By injecting energy into the plasma process the temperature of the ions is increased, the electron/ion temperature ratio is reduced and this has the desired effect of agglomerate size reduction.

Innovative Aspects

This is the first method to make full use of the knowledge of the physics of plasma dusts. Other approaches aimed at removing or destroying dust agglomerates from plasmas have been less than completely successful. This is the first approach that is relatively low cost in its implementation and makes full use of the physics of the system.

Application Fields

The techniques can be applied to plasma etching of silicon wafers and in the production of high-quality plasma-deposited coatings, where plasma dust particulate is often a problem.

Status

The technique is patented and licenses are available. Initial tests have supported the theoretical predictions, but confirmation from laboratories around the world is awaited. The full confirmation of the results will be available by the time of publication and information is available on request.

Ref. 358

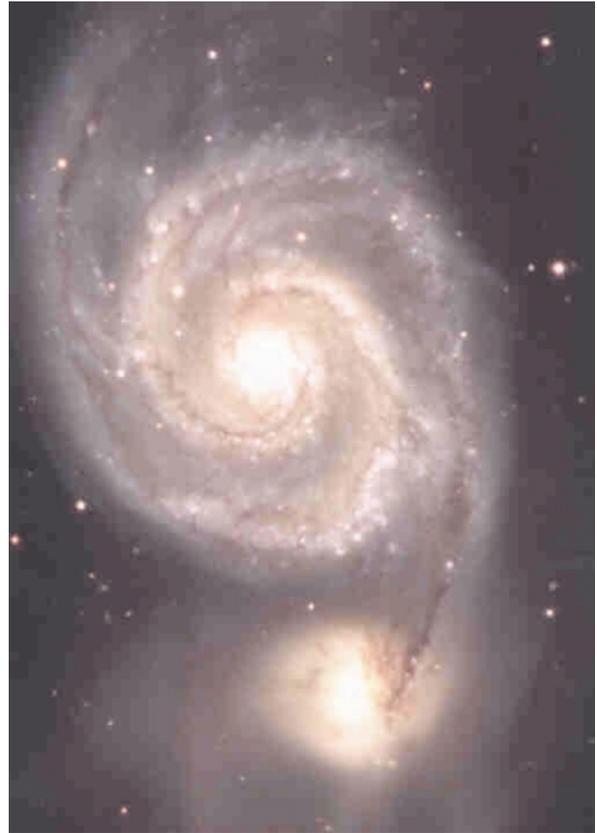


TABLE WITH PROJECTING TOP

Description

Tables in our daily life usually have 4 legs and are made of wood. These basic principles do not change even in the case of designer tables. 'TaVolo' on the other hand may be differentiated for its uniqueness in the following way:

- its design is 'patentable', due to its unique suspension/fixation method;
- it uses carbon, aramid, or glass-fibre-reinforced plastics or a mix of the three materials, not very common in consumer mass markets like furniture.

It is furthermore essential that the table is built with three parameters in mind:

- a maximum of safety for the consumer (who has to get used to the new type of table)
- a minimum of carbon/aramid utilization to keep costs down, but strengthening of areas where it is absolutely necessary due to load maxima
- an optimum manufacturing process with, for example, specific attention to the visible surfaces, thus appealing to the consumer, means not all types of resins can be used.

To this end, a calculation method, like 'ESAComp' is needed to give a 'layer-by-layer' and a fibre direction dependant stress figure around the critical areas of the product, such as:

- around the holes for the fastening bolts and the foot for moment forces introduction
- the table plate itself, where often too many material layers are applied.

In addition, 'ESAComp' would give a thermal conductivity analysis for applications such as individual cooking surfaces in the table plate.

Innovative Aspects

A cost-optimized design for a consumer product in the furniture market based on:

- a European Patent of a single-side suspended table
- typical aerospace material and processes
- ESA computer software (ESAComp) for optimized material consumption.

Application Fields

Furniture design for consumer markets.

Status

The inventor is interested in joint ventures, sale of patent or licence agreements.

Ref. 359



COMPUTER HARDWARE AND SOFTWARE

UMLNICE, A TOOLSET SUPPORTING UML

Description

UmlNICE is a CASE product conceived to provide full support to UML (the Unified Modelling Language), an object-oriented notation standardised by the OMG, which is rapidly becoming a de-facto standard for the modelling of systems, of software and of processes. UmlNICE is implemented in Java, thus providing complete portability on a wide range of hardware and software platforms (including Unix and Windows).

UmlNICE has been developed based on the experience gained by the donor in aerospace programmes such as:

- participation in the definition of the HOOD method
- contribution to the definition of standard development processes (ESAPSS-05, PSS-01-21, ECSS)
- development of CASE products for supporting the HOOD and HRT-HOOD methods
- participation in the design, tool selection and integration of Software Development Environments (ESA ESSDE, Columbus, Hermes, Helios and ATV SDE).

The main features of UmlNICE are:

- Integrated Editors

Different editors are provided to support the various diagram notations of UML: *Use Case diagrams, Class diagrams, State Chart diagrams, Activity diagrams, Sequence diagrams, Collaboration diagrams, Component diagrams and Deployment diagrams*. This set of editors is completely integrated.

- Easy Extensibility

Through a sophisticated support to the UML extensibility features (*Stereotypes, Constraints and Tagged Values*) new Editors can easily be added for supporting customised UML notations. A HOOD (Hierarchical OO Design) set of editors has been built in this way and included in the package.

- OCL Support

A full OCL (Object Constraint Language) interpreter is provided supporting real-time checks of pre-defined and user-defined model constraints.

- Multi-platform availability

Fully implemented in Java, UmlNICE is available on virtually any platform, including Windows and Unix. All the major components of the toolset (Desktop, Editors, Generators, Analysers, System Model Managers (SMM) and System Models (SM)) are implemented as CORBA objects, thus allowing one to take full advantage of the benefits brought by a standard distributed object computing platform, including: transparent distribution (also over Intranets and the Internet through the IIOP protocol), ease of extension and openness.

Innovative Aspects

The major features of UmlNICE can be summarised as follows:

- Full support for the UML notation.
- Integrated support for the HOOD method, and for smooth migration from HOOD to UML.
- Full portability and interoperability across a wide variety of hardware and software platforms: UmlNICE is fully implemented in pure Java thus making the toolset available on virtually any platform, including Windows and Unix.
- Scalable component-based architecture. All the major components of the toolset are realised as CORBA and Java components. This takes full advantage of the benefits realised through a standard distributed object computing platform, including: transparent distribution (also over Intranets and the Internet through the IIOP protocol), and ease of extension and openness.
- Flexible CORBA-compliant Component Communication Infrastructure (CCI). Two implementations of the CCI are available: a light-weight, single address space version, which supports the single user version of the toolset; and a full-fledged CORBA implementation, including a commercial Object Request Broker (ORB), which supports the Enterprise version of the toolset that provides multi-user, multi-site support.

Application Fields

The principal application field of the product is for the analysis and design of software applications. However, because of the features of the UML, the product is also applicable for the specification of complete systems and in particular for modelling the relationships among hardware and software components.

Status

UmlNICE is packaged in three editions:

- *Basic Edition* is implemented as a lightweight single user version of the toolset, providing a complete set of modelling functionalities.
- *Professional Edition* extends the basic edition with generation and analysis capabilities, including code and documentation generators.
- *Enterprise Edition* extends the professional edition with multi-user, multi-site functionalities. It exploits the availability of a full-fledged CORBA Component Communication Infrastructure to provide sophisticated extensibility and integration mechanisms.

The donor has complete ownership and copyrighting of the product. Free evaluation licenses for the Basic Edition are available. Product sales are envisaged.

Ref. 360



MULTIMEDIA ARCHIVE AND MANAGEMENT (MEDA)

Description

Massive database storage and management systems have become critical. Video and image storage requirements place increasing demands on their management tools. Accordingly, complete audio/video/data storage and management systems have become more sophisticated, offering faster access time.

The system was developed to accommodate different information inputs (long-term archive films, analogue tapes, digital information, etc.) and be compatible with current standards (such as MPEG-1; MPEG-2; MPEG-422 or MJPEG), in order to catalogue, archive and enable user friendly information retrieval and offer a browsing capability. The system can use high-quality video compressed and metadata information. Possibilities to adapt to different customer requirements and new information inputs or outputs can be incorporated very easily.

MEDA has been designed to meet Service Provider problems, with video as the main content of the archive. The system works on a three-level scheme:

- The Multimedia Catalogue, a database dedicated to search functions containing full documentation of all the items stored in the archive (text, audio, still images and video clips).
- The Album, a low-quality copy of the archive for browsing purposes, designed to provide fast access without using the high-quality material.
- The Archive, containing the high-quality video to be retrieved for final utilisation.

Innovative Aspects

Advantages of the proposed solution include:

- Improvements in searching and browsing of information
- Provides an integrated system for audiovisual management and cataloging (i.e. Video, Images, Audio,...)
- Allows sharing of the central storage infrastructure among all areas
- Integrates different systems and formats across all areas
- Facilitates an ordered integration process for all areas
- System expansion capability, both in terms of storage capacity and bandwidth
- Possibility to develop customised user applications

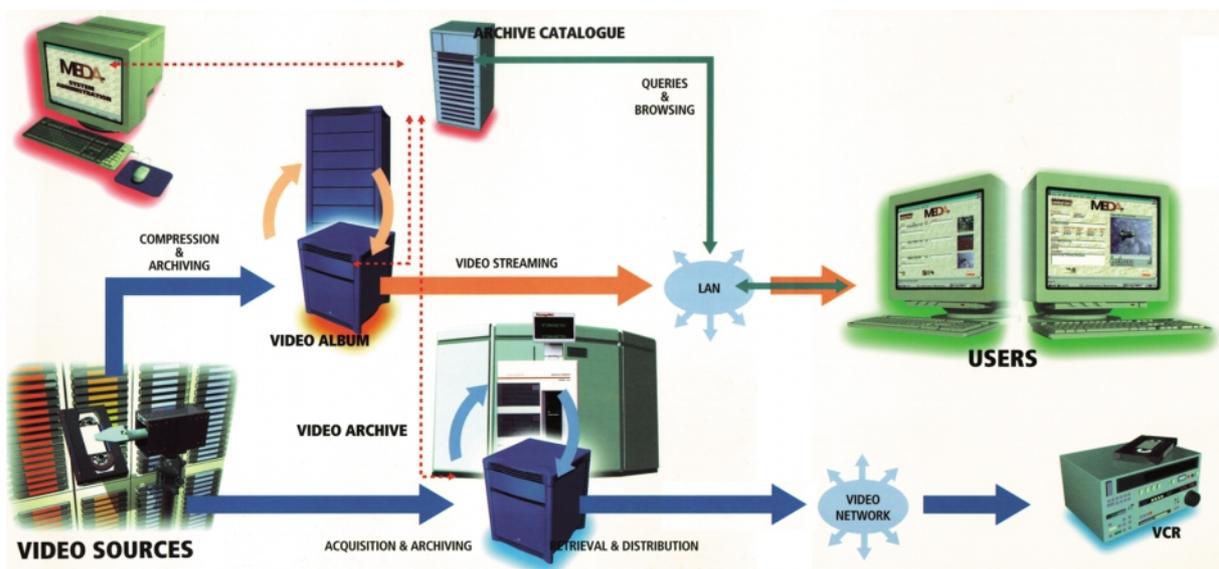
Application Fields

MEDA has potential applications in audiovisual, television, production and post-production activities.

Status

The technology is in a pre-marketable phase.

Ref. 361



ESA SIMULATION LANGUAGE (ESL) WITH NEW GRAPHICAL USER INTERFACE

Description

The European Space Agency general simulation tool ESL has been in widespread use for several years, and has undergone continual improvement. A new NT-compatible graphical-user-interface called the Integrated Simulation Environment (or ISE for short) has been developed to improve the man-machine interface of ESL. ESL is a recognized standard in continuous system simulation languages. Originally developed for ESA for use on advanced space projects, it is now widely used in industry and academia for applications requiring *accurate* and *robust* computer simulations of dynamic systems. ESL has the following features:

- robustness *↳ simulation engine that runs forever*
- handling of very large models
- extensive checking of model *correctness*
- accurate treatment of discontinuities
- wide range of numerical integration algorithms including stiff algorithms
- vector and matrix arithmetic
- both differential equation and transfer function model description
- submodel concept allowing hierarchical modelling of complex systems
- distributed simulation over a number of computers
- interpreter mode or translation into FORTRAN or C++
- embedded simulation and interface to other programs
- snapshot facility allowing the state of a simulation at a specific time to be saved for resumption later
- real-time capability.

Model building and simulation execution using ESL ISE:

ISE is the development environment from which you can manage each stage of the simulation activity.

ISE includes a graphical editor for block diagram style model descriptions, while allowing textual ESL code to be used where appropriate (for example, to describe highly non-linear elements). Standard simulation elements are selected from a palette and interconnect on a canvas to build up the simulation description.

ESL submodels can be created and included in a diagram through a special submodel element. The option to configure the simulation element palette itself with user-defined submodels allows the creation of application specific *toolboxes*.

Once you have created a simulation program (graphically, textually or a combination of both), compilation is initiated from ISE. The option to execute the program immediately through an interpreter, or further translate it to FORTRAN or C++ is available. The resulting executable program may then be run

from ISE. In either case, execution is managed by an interactive control panel which provides run-time control of the simulation.

All program variables and parameters can be accessed from the control panel. This includes simulation parameters such as the communication interval, final simulation time, choice of integration algorithm and error tolerances. All variables and parameters can be set and changed dynamically from the control panel.

Graphical and tabulated output can be specified on the block diagram through the use of special simulation display elements or alternatively from a versatile display manager window.

All run-time commands and output specifications can be logged to a driver file that can be used at a later time to repeat simulation scenarios.

Innovative Aspects

ISE – Integrated Simulation Environment is the powerful new graphical user interface to ESL. It provides:

- a multi-window graphical block diagram editor for a model construction
- inclusion of ESL coded submodels where appropriate
- interactive control of simulation execution
- run-time and post-run graph plotting
- user configurable simulation element palette
- application specific toolbox capability
- display manager
- on-line help.

Application Fields

The ESL-ISE software simulation tool can be applied to a wide range of engineering problems, which involve the simulation of dynamic systems. The mathematical models can be presented either in terms of differential equations or in a block diagram transfer function form (or a combination of both). To date ESL has found uses in areas as diverse as gas turbine driven compressor systems to major gas pipeline gas distribution systems. Other current application areas include:

- simulation of water treatment plant
- aero industry - e.g. actuator simulation
- process industry
- marine applications - e.g. submarine training simulator
- nuclear industry

Status

The ESL-ISE simulation tool was completed in August 1998 and is available for use in both the space and non-space sectors. ESL-ISE is protected by software copyright.

Ref. 362



RAISE—RIGOROUS APPROACH TO INDUSTRIAL SOFTWARE ENGINEERING

Description

RAISE facilitates the use of formal methods in the development of software systems. It encompasses a powerful specification and design language (RSL), a comprehensive method, and extensive tools support.

The RAISE toolbox consists of a number of syntax directed editors, including a:

- Module editor for making RSL specifications with continuous syntax and semantic checks.
- Theory editor for specification definition.
- Development relation editor to specify formal relations between refinements of specifications.
- J justification editor to perform justifications, including formal proofs, of properties of specifications, development relations, etc. Includes intelligent “matcher” and simplifier for proof rules.
- A RAISE library with flexible management capability for storage of specifications, theories etc.
- Pretty-printer for RSL.
- Translators from lower level RSL specifications to Ada and C++.

Innovative Aspects

Although rooted in VDM, RAISE provides more general, powerful and more broadly applicable features than formal methods such as VDM and Z. RAISE also encompasses specification and design techniques derived from the algebraic specification approach.

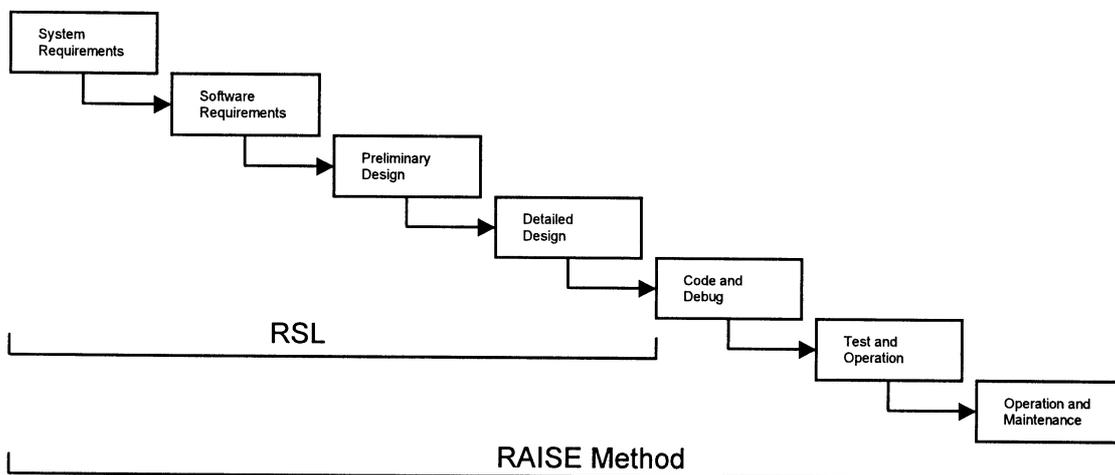
Application Fields

- Systems software
- Embedded systems
- Safety critical software.

Status

The technology is currently used by several companies both inside and outside the space sector. A full documentation package is available and five-day tutorial courses can be organised. The system is available on SUN Spark UNIX platforms.

Ref. 363



ESACOMP – TOOL FOR ANALYSIS AND DESIGN OF COMPOSITE MATERIAL SYSTEMS

Description

The system is coded in C for MS Windows and UNIX/X Window/Motif environments. The main features of ESAComp are:

- Laminate analysis and design capabilities (Version 1.0)
- Analysis and design capabilities of structural elements (Version 2.0)
- Efficient user interface
- Working environment based on the case concept
- Multilevel database
- Numerical and graphical result displays
- Interfaces for finite element programs
- User extensions.

ESAComp Version 1.0 Capabilities are:

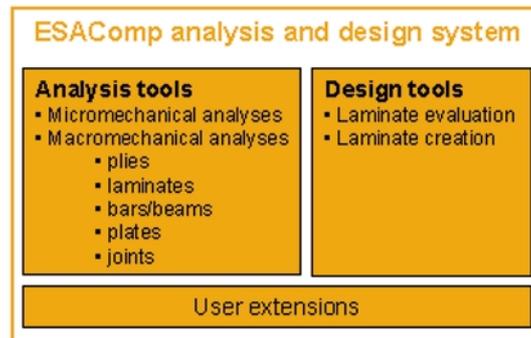
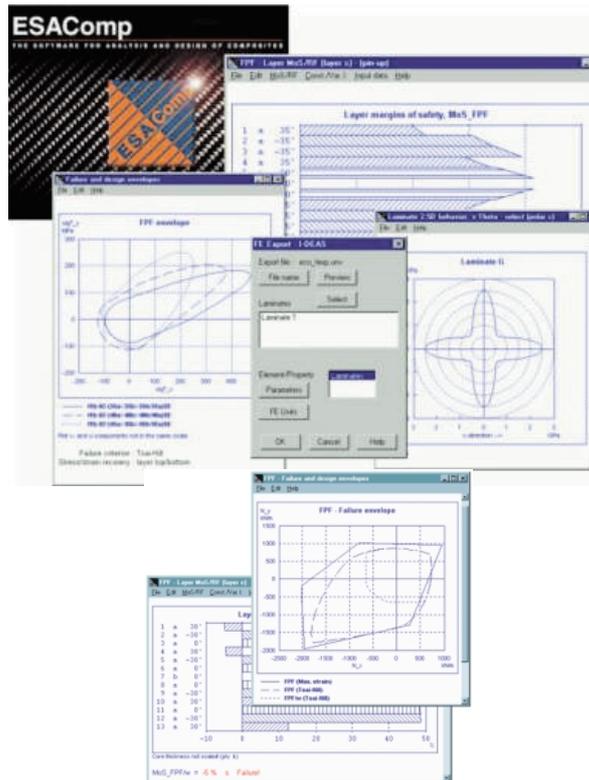
- Stiffness and load response analyses of laminates (solid/sandwich) based on the CLT
- Failure analyses of laminates
- First Ply Failure (FPF) analyses
- Degraded Laminate Failure (DLF) analyses
- Several commonly used failure criteria and a possibility to add user specified criteria
- Free-edge analyses
- Straight free-edge
- Layer drop-off analysis
- Multiple analyses and graphical result displays
- Multiple plies/laminates/loads/failure criteria
- Laminate orientation as a variable, polar charts
- Layer orientations as a variable
- Ply carpet plots for (0/90/ $\pm\theta$) laminates
- Failure and design envelopes of laminates
- Sensitivity studies
- Tolerance for ply property or layer orientation
- Laminate design
- Evaluation of plies/laminates against a given design specification
- Export of laminate lay-ups/properties into FE programs
- ANSYS, I-DEAS and MSC/NASTRAN
- Data bank
- Data for commonly used aerospace materials and material systems.

Innovative Aspects

ESAComp will provide:

- a sophisticated user interface
- multiple analysing tools
- a laminate design tool
- data export/import with several FE programs
- a materials data bank.

ESAComp is the first commercially available comprehensive laminate analysis program.



Application Fields

Developed primarily for use in aerospace, ESAComp is also available for use in non-space applications that can usefully exploit the design and analysis of composite materials.

Status

Version 1.0 is commercially available and version 2.0 will be launched in 1999. A preliminary evaluation version was delivered in April 1996 to sixty ESA affiliated companies and research institutes.

Ref. 364



ECONOMICAL DEVELOPMENT OF SOFTWARE AND HARDWARE-SOFTWARE PRODUCTS

Description

The economical, cost-efficient development of high-quality software in the areas of data processing, system automation and autonomous systems is based on a methodology which was defined and proven for systems having high demands regarding availability and reliability. It brings the same quality for normal industrial applications at reasonable cost.

The development environment EaSySim II (Early System Validation of Design) supports early identification of risks, provides an engineer with guidelines for efficient development, and supplies a large number of generic, reusable functions which make it easy to get an executable system. An implementation of EaSySim II towards an industrial product is CADIS (Central And Distributed data acquisition and processing Integrated System). CADIS acquires and processes data at the central and/or remote sites based on transparent distribution of the system's functions, allowing for continuous system evolution and integration of application-specific functionality.

EaSySim II and CADIS support a developer in getting feedback from an executable version, by which he can confirm and prove the actual behaviour, functionality and performance of the system under development. System validation is provided by the EaSySim II simulation environment. The incremental development approach and the ability to navigate arbitrarily between simulation, validation and target environment allow for coherent transitions between the phases of the development life cycle. Moreover, the application software may be ported to different platforms and operating systems without being forced to adapt its interfaces.

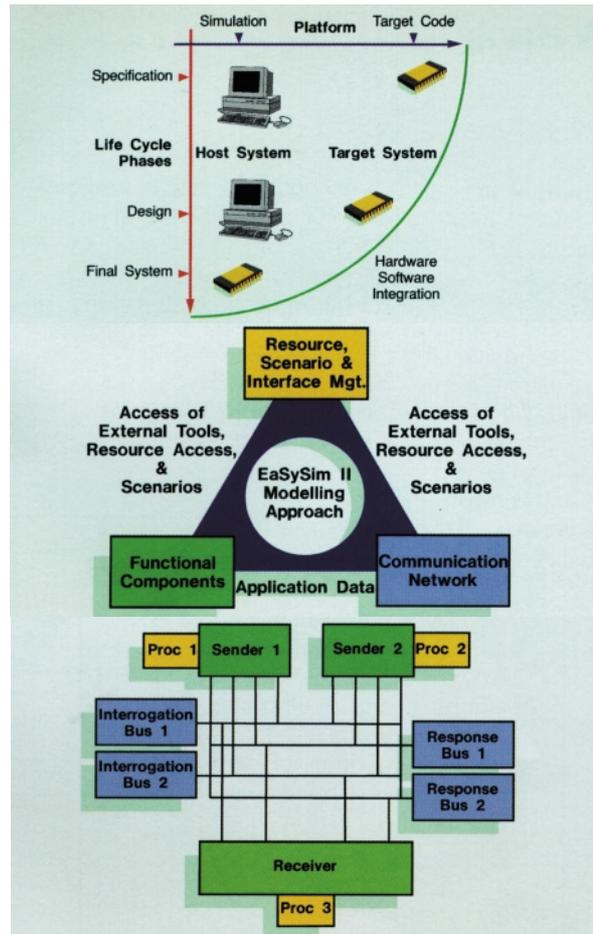
Application -specific

Apart from concepts and guidelines EaSySim II provides a large number of generic functions which support communication via LAN (Ethernet), WAN (ISDN, modem), RS232 etc. and transparent distribution of a system's functionality across a network, including monitoring of the remote sites from the central site. Depending on the actual needs, system functions may be allocated to a central or a remote site. Larger systems may be composed from basic system units. Such system upgrades may serve to provide fault tolerance and/or higher performance.

CADIS supports automated and autonomous data acquisition and processing within a distributed system, and interfaces for integration of application specific functions. Through this support a complex (distributed) system can be implemented within a rather short time at reasonable cost.

Innovative Aspects

Minimisation of development risks by system



validation already in an early development phase is based on: executable models (executable specifications), performance based modelling of a system's behaviour, automated transition between simulation and validation, development and target environment, automated testing, fault injection, stress testing, support of transparently distributed systems, high flexibility of system configuration, extension towards fault tolerance, scalability of performance, intrinsic overload protection, remote diagnosis and operation across the network, automated operator alarm in case of actual or future critical system states, reconfiguration without recompilation, update of software during on-going system operations, automated, system-controlled, coherent networkwide software update.

Application Fields

Cost-efficient, economical development and validation of high-quality embedded systems or software, autonomous systems, distributed data acquisition and processing, systems in the area of automation. Also systems in non-technical areas

Status

The technology donor is interested in all types of co-operation, including consultancy and/or technology support and joint ventures

Ref. 365

GAMMA SAR AND INTERFEROMETRY SOFTWARE

Description

The GAMMA Modular SAR Processor (MSP), Interferometric SAR Processor (ISP), Differential Interferometry and Geocoding Software (DIFF & GEO), and Land Application Tools (LAT) are modular software packages used to process synthetic aperture radar (SAR) images. The software packages run on SUN/HP/DEC/SGI workstations under the Unix operating system and are written in ANSI C language, which was chosen for its portability and efficiency in the processing of large data sets.

The well documented structured code and the stepwise processing approach permit users to experiment with new algorithms and applications. Data from both spaceborne and airborne sensors including ERS-1/2, JRS-1, SIR-C, SEASAT, RADARSAT StripMap mode, and the single-pass Dornier DOSAR interferometer have been successfully processed interferometrically. User-friendly display tools and full documentation in HTML language complement the software. Both binary and source code licences are provided. Up-to-date algorithms were implemented to achieve accurate processing of the data, while permitting efficient processing of large data sets on a workstation computer.

Innovative Aspects

- Use of up-to-date algorithms for SAR and INSAR processing
- Accurate, efficient processing
- High flexibility.

Application Fields

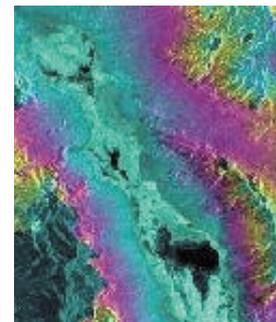
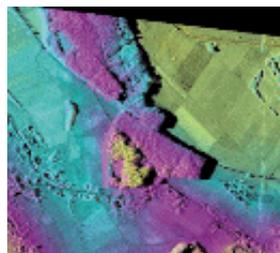
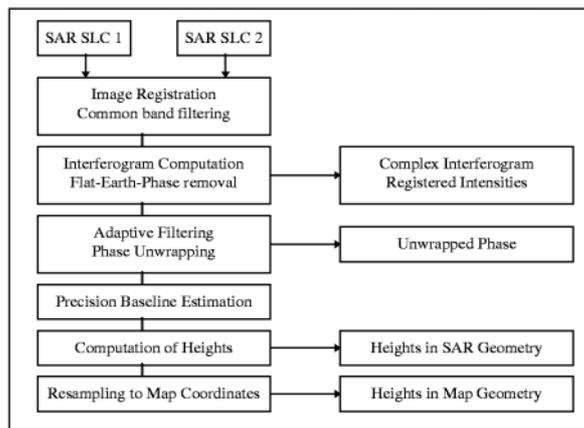
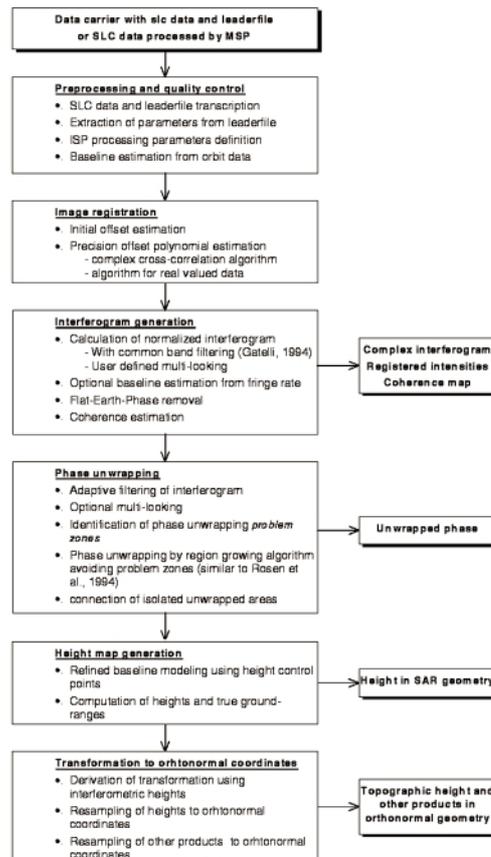
All kinds of earth observation with SAR (space- and airborne)

Status

Licences are available.

Ref. 366

Interferometric SAR Processor (ISP): flow chart



SPACE RADAR REMOTE SENSING & SURVEILLANCE SOFTWARE TOOLS

Description

In support of the Next Generation SAR (Synthetic Aperture Radar) space-based radar instrument study undertaken for ESTEC, a SAR Performance Analysis tool, *NextPerf*, was developed. The package is the fruit of a successful international collaborative venture between a technical consultancy specialising in signal processing systems and software development and a major space-industry prime contractor.

The tool provides a powerful and comprehensive suite of analysis functions supporting full engineering level analysis of Strip-line, Spotlight, Quad-Pol and Burst- & ScanSAR modes of SAR operation. The tool is usable from the earliest investigations into feasibility through to construction and calibration/validation.

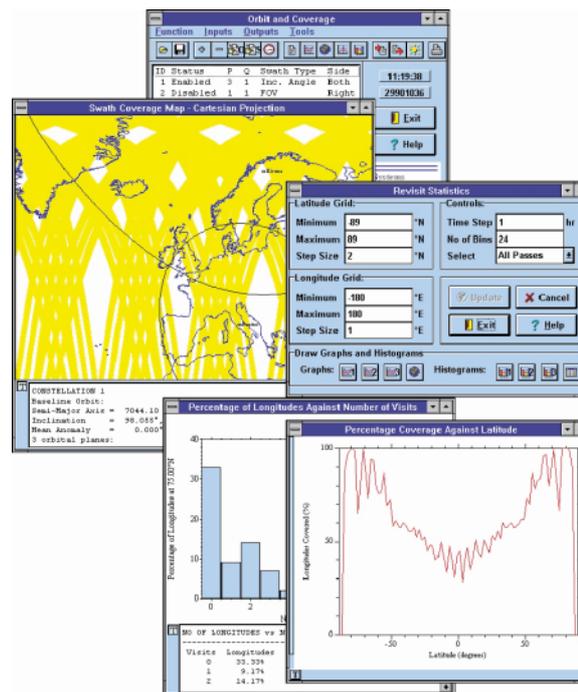
NextPerf is but one of a range of software products developed to meet specialised radar analysis application requirements. *SAR Processor*, as the name implies, generates images from the raw data captured by space-based SARs. *SAR Processor* can handle common satellite data (ERS-1 and 2; Radarsat) as well as Seasat and the Russian Almaz data-sets. SSATS, the Space Systems Analysis Toolset, is a three module tool-kit supporting the analysis of earth observation or surveillance mission parameters to meet remote sensing mission objectives. The SSATS O+C module helps in the selection of an orbit for one spacecraft (or a constellation) to meet ground coverage and other astrodynamical requirements. By simulating the scheduling of user requests against the chosen space segment, the SSATS SMS Module increases confidence that the space segment specification (and thus cost) have been correctly estimated to meet anticipated demand. If the mission includes a SAR instrument, the third module SSATS SPA provides a quick and easy 'what-if' analysis tool to conduct a first-pass SAR Performance Analysis, before turning to tools such as *NextPerf* for investigation in-depth.

Innovative Aspects

All the software packages described have been developed to run on desk-top PCs, providing flexibility and ease of use. The user-interface takes advantage of the familiarity of menu-driven GUIs, for example, MS Windows-95®, to reduce the time required to learn to use the software. *SAR Processor* in particular demonstrates that it is possible to offer a highly capable processor for Synthetic Aperture Radar data for an exceptionally cost-effective outlay when real-time processing is not an issue.

Application Fields

The donor company is offering bespoke solutions to the telecommunication, sonar, radar and other



sensor technology industries.

Status

Single-user and Site licences are available for all the tools mentioned above. All tools run on 100% IBM-compatible PCs under MS Windows-95®.

The capability to successfully implement these tools depends on a comprehensive technical understanding of signal processing and platform dynamics, and the project management skills and rigour to produce ergonomic, reliable applications software to meet the specific needs of a group of users. The donor company wishes to exploit its skills in signal processing; mathematical modelling and simulation and hardware/software development in other specialist areas.

Ref. 367



AUTOMATION AND ROBOTICS

SOFTWARE-PROGRAMMABLE MAGNETICALLY LEVITATED ISOLATION AND POSITIONING DEVICE

Description

This technology (known as MIM) is a magnetic levitation device composed of two main components: a stationary base called a Stator and a magnetically levitated working surface, called the Flotor, which is the only moving part. The stiffness and damping of the Flotor's position controller in the three translation (x,y,z) and three rotational (pitch, roll and yaw) axes are software programmable. The Flotor is levitated from the Stator and is actuated by eight Lorentz force actuators. This actuator is a configuration of a passive element (two magnets placed parallel to each other and separated by a gap) and an active element (flat copper coil) placed in the gap between the magnets. When combined, the two elements form a device that can apply or resist force. The magnets are fixed to the Flotor, while the coils are fixed to the Stator. Forces (to move the Flotor) or compliances (to resist motion placed on the Flotor) are generated by the control algorithm which regulates the current levels passing through the coils of each of the actuators. The vector sum of all the translational and rotational forces determines the x,y,z, roll, pitch and yaw motion of the Flotor. Position and orientation of the Flotor are determined by three light-emitting diodes imaged onto three Position Sensing Devices, resulting in a position accuracy of the order of 100 microns. This could be improved considerably for more precise applications.

Innovative Aspects

The innovative aspects of the MIM are: non-contact, frictionless interface; Lorentz actuators, which allow for bi-directional motion along each DOF; linearity of applied force with current; high speed and high precision positioning; simplicity of design; software programmable 6 DOF motion, compliance, damping and frequency response; and Software Simulation Models and Design Tools.

Application Fields

- 6 DOF programmable shaker-motion simulator
- Aircraft reduced gravity experiment services
- Force feedback hand controllers
- Positioning, Pointing and Tracking devices
- Sensing devices.

Status

Prototypes are available. Licences sought.

Ref. 368



HEXAPOD POINTING SYSTEMS (HPS) FOR HIGH-ACCURACY POINTING AND POSITIONING APPLICATIONS

Description

Hexapod Pointing Systems (HPS) are capable of controlling the position of a movable flange with respect to a fixed flange. They can exploit up to six degrees of freedom (DOF), and are therefore composed of six linear actuators arranged in the shape of three trapezia, interconnected by twelve universal joints to a lower and an upper mounting flange.

The payload (i.e. instrument or tool) is accommodated on the upper mounting flange, while the lower mounting flange is connected to a fixed base. Positioning in space of the upper flange (and hence the payload) is achieved by electronically controlling, in a co-ordinated manner, the lengths of the six actuators.

These HPSs can provide high accuracy pointing and positioning thanks to the following features:

- ball or cylinder screws
- properly pre-loaded universal joint bearings
- rotary encoders or LVDTs for position sensing and feedback to the control loop
- light but robust aluminium structure, machined from a solid piece of aluminium.

The system has a statically determined truss-type structure, such that:

- its control law is robust and can cope reliably with disturbances coming from the outside environment
- thermal deformations do not induce loads
- there is still movement (graceful degradation) possibility if an actuator jams, after switching to a control law modification
- it has a high stiffness vs. mass ratio.

Innovative Aspects

Hexapod systems exist, at least in engineers' minds, based on the discovery of Euler angles, but the technology used by these HPS allows for an accuracy at least one order of magnitude better than currently available systems on the market.

The use of customized linear actuators, coupled with the relevant control laws, has led to the following results related to two different applications of the hexapod systems:

	Six DOF	Five DOF
pointing envelope (degrees)	+/- 10	+/- 1
pointing accuracy (arcsecs)	+/- 5	+/- 1
linear accuracy (microns)	+/- 20	+/- 5
stiffness (Kg/micron)	5	5
payload mass (Kg)	50	20



Application Fields

Typical applications include:

- positioning tool for manufacturing machinery
- component positioning on optical benches
- high accuracy in extreme environments, typical of robotic arms
- high-precision pointing of ground-based instruments
- attitude compensation of payloads and instruments installed on airborne platforms
- ground-station telemetry and telecommunications link tracking for LEO satellites
- coarse pointing of ground-based-telescope secondary mirrors (for thermal distortion compensation of telescope main structural members and optical components).

Status

Two versions of HPS have been produced so far:

- a six DOF HPS, providing a stable platform for an instrument, accommodated on an airborne platform, and compensating for attitude errors generated by the platform drift itself
- a five DOF HPS, providing coarse pointing for the adaptive secondary system of a ground-based telescope.

Cooperation for the development of specific applications is sought.

Ref. 369



VISUAL MONITORING CAMERA

Description

The Visual Monitoring Camera (VMC) is a small camera developed for space applications.

The camera is based on a CMOS addressable active pixel detector. The detector type can be a FUGA15d or IRIS1. Black and white or colour versions are available. The dimensions of the camera are 65 x 60 x 103 mm, and it weights 430 g.

The camera objective has a Field of View of 29° x 29° if used with an FUGA detector, and 40° x 31° if an IRIS detector is used. With this camera objective, sharp images can be obtained at object distances between 3 metres and infinity.

In space, this camera can be used for observation of the deployment of antennae and solar panels on board a satellite. The camera allows for direct communication with the satellite for image transfer.

Application Fields

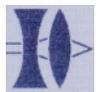
Although the camera has been developed for use in space, it can be usefully exploited in industrial applications. In particular, it can be used in ultra-clean environments for biological or medical applications. The camera can also be equipped with dedicated electronic circuits to meet customer-specific applications.

Since these cameras can resist high vibration levels and large temperature variations, they can also be used in hazardous environments and outside normal temperature ranges.

Status

At the moment, a pre-series of these cameras is in production. A small number of flightworthy cameras will be delivered to ESTEC within a few months. It is possible to adapt the design of the camera to meet specific non-space applications. Batch processing techniques will ensure that manufactured products meet exacting delivered time scales.

Ref. 370



SENSORS AND MEASURING TECHNIQUES

■ POROUS-SILICON COLOUR SENSORS

Description

Porous Silicon (PS) is produced by electro-chemical anodisation of commercially available silicon wafers. The PS technology developed controls porosity (mean density) and thickness, from 20 to 90% of the mass density of bulk silicon, and from a few nanometres to hundreds of micrometres of layer thickness. All the physical properties of the Porous Silicon are strongly affected by its level of porosity, i.e. thermal, electrical and optical parameters like optical absorption and reflectivity.

By combining alternating layers of different porosity in the depth of the wafer with photolithographic surface structuring, it is possible to realise arrays of Bragg reflectors centred at different wavelength corresponding to the red, green and blue region of the optical spectrum. The Bragg peak can be positioned and shaped by a proper choice of refractive index, thickness and number of the layers. Reflectivity of these optical devices reaches 98%.

Innovative Aspects

Colour sensors have been realised with p-n junctions of different depths, using dyes to select the working wavelength. These devices are complicated and require complex fabrication processes, which are not fully compatible with standard silicon process technology. The Porous Silicon colour sensor consists of three different p-n junctions located in three different areas of the Si chip. The three junctions are covered with three Porous Silicon Bragg reflectors with peak wavelengths in the blue, green and red parts of the visible spectrum. These modulate the optical response of the three photodetectors in order to select the different colours. This technology is fully CMOS-technology compatible and allows the integration of the sensor and control electronics on the same chip.

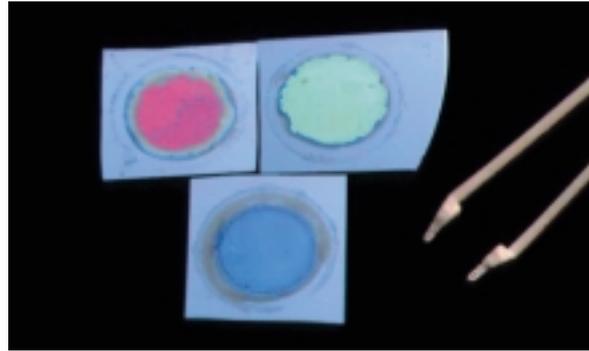
Application Fields

The most important application fields for these colour sensors are computer peripherals and multimedia (scanners, colour faxes), imaging (video cameras) and satellites for environmental monitoring (oceans, seas).

Status

The technology is not patent-protected. The company is looking for an industrial partner to support large scale fabrication and distribution of a commercial product.

Ref. 351



■ HYDRACAM – MULTI CHIP VISUALIZATION SYSTEM

HYDRACAM is a compact, computer controlled, object visualization system with an integral special illumination unit.

The HYDRACAM system is based on progressive-scan multichip technology. All parameters of the video unit can be adjusted digitally through software. This guarantees fast customisation for specific applications, as well as, ease in making corrections and the capability to precisely set up duplication from individually recorded parameters without any problems. The illumination unit is completely integrated in the recording video head and is thus also steerable both directly and digitally. These elements are combined with a quick self-testing optimizing visualization unit SOVIS® and constitute the core of the HYDRACAM system.

The main function and special feature of this system is the self-optimized video object capture without manual interference. Similar systems on the market are complex, difficult to install and operate, and expensive. These systems can be replaced by HADRACAM which offers greater simplicity, more consistent and reliable performance, and lower cost both for initial installation and for continuing operation.

Innovative Aspects

HYDRACAM delivers optimized video pictures of objects along with digital evaluation of preselected parameters at the same time. In addition, the advanced self-learning features of this system give a high-level capability currently only obtainable with very expensive and complicated equipment. At the same time, nearly all functions are handled automatically with custom software making it very user friendly.

Application Fields

HYDRACAM has been designed to measure quality parameters that are detectable by visual inspection and compared to pre-established norms of acceptability. This can be extended to acceptance/rejection control in volume production lines. It can also be applied as a flexible and high-speed measuring system.

HYDRACAM is fundamentally simple to set up and its flexibility makes it easy to adapt to a wide variety of uses and applications.

Status

The developer and owner of HYDRACAM technology will provide guidance and knowledge in the use and applications of these devices. Inquiries are welcomed as are opportunities for project cooperation in industrial and research applications.



Ref. 352



OPTIMAT, NEW DEFORMATION MEASUREMENT SYSTEM FOR STRUCTURES MADE OF TEXTILES OR SOFT MATERIALS

Description

The measurement of deformations in structures made of textiles or soft materials is a common problem in industry. OPTIMAT is a complete instrumentation tool, linked to a data-processing system that uses the standards in instrumentation software.

With OPTIMAT, it is possible to validate and optimise design calculations, to control installation of the structure, to survey the structure during its use and to qualify a structure regarding requirements.

Measurements of deformations (elongation or shrinkage) of the material during periods of use, are achieved through the spatial variation between two straps induced by a deformation of the sensor body. The subsequent signal variation is proportional to the material deformation.

Innovative Aspects

Low-weight sensors (< 4 grams) prevent any interference with the behaviour of the structure. The real deformations measured can be transformed into stress measurements with the data processing system appropriate to each material.

This device is available for applications both in the laboratory or in-situ.

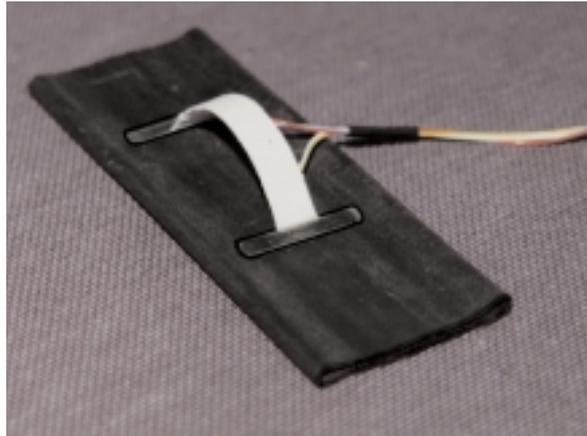
Application Fields

OPTIMAT allows the behaviour of structures made of textiles or soft materials (like balloons, sails, inflatable boats, tents, aeroplane emergency chutes, toboggans) to be analysed.

Status

The company is interested in any collaboration, from distribution to partnership for specific applications or transfer of know-how.

Ref. 371



HAND-GRIP AND PINCH-FORCE DYNAMOMETER

Description

Force measurement is one of the fundamental parameters used to evaluate the physical performance of an astronaut and the effect of weightlessness during prolonged space missions. Under an ESA contract, the donor company has developed a system to measure the hand and opposed finger force, designed for on-board use in the Human Research Facility.

The system is composed of a Hand-Grip Dynamometer (HGD), a Pinch-Force Dynamometer (PFD), and a connecting unit (SCU) to interface the equipment with a power supply (28Vdc) and computer (PCS).

As far as anthropometric features are concerned, the system has been developed to accommodate the 5th percentile Asian female to the 95th percentile American male. The system has an accuracy of 0.75%, a long-term stability which guarantees a recalibration cycle over two years, and is independent of the application point of the force.

The system is based on "strain gauge" technology with a high stability and low noise amplifier integrated into the transducer. The system has a frequency response up to 20 Hz and has the possibility to manage the automatic reset and the calibration control through the computer. Furthermore, every transducer is given its own recognising code, allowing the flight software to automatically use the specific parameters for calibration.

The HGD module allows force measurements developed by the hand grip up to 1000 N while the PDF module allows force measurement developed by the thumb and other fingers in opposition up to 270 N.

Innovative Aspects

The innovative aspects of the system include:

- Providing a hand-held device for measurement of isometric force
- Accommodating the 5th percentile Asian female to the 95th percentile American male - the distance between the parallel beams is adjustable and handgrips widths and lengths are adequate for this population
- Battery powered
- Providing comfortable hand grips
- Providing comfortable thumb and finger contacts
- Providing a calibration method.



Application Fields

Envisaged applications include:

- physiotherapy improvement monitoring of patient
- force measurement forming part of the physical examination in personnel recruitment programmes for the police force, governmental bodies, etc.
- virtual reality.

Status

The system has been developed under an ESA contract. Prototypes are available.

Product sales or development of customised solutions is envisaged.

Ref. 372



METAL FILM BOLOMETERS ON HIGHLY POROUS SILICON LAYERS

Description

A bolometer is usually composed of an absorber, dependent on the radiation being detected, and a thermometer to measure temperature variation of the system which is thermally insulated from ambient conditions. In metal film bolometers, the absorber and thermometer are coincident, and the temperature variation is determined by the resistance variation of the film. This type of detector competes favourably with semiconductor devices on the market due to its low fabrication costs and the wideband response, extending into the far infrared (hundredths of microns to 1-20 microns).

The sensitivity of metal bolometers is inversely proportional to the thermal conductance between the device and its substrate and so this feature has been minimised in an innovative way. This has been achieved by depositing the metal film on silicon or a silicon nitride thin membrane obtained by bulk micromachining processes.

Innovative Aspects

The realisation of high-porosity silicon layers with very low thermal conductivity allows the fabrication of metal bolometers onto this kind of substrate. Shorter processing times, better compatibility with silicon microelectronics technology, and low costs are the most relevant advantages. The first bolometer realised on 65 porosity layers exhibited a sensitivity of 50 V/W. This value can be further improved by using higher porosity substrates.

Application Fields

This detector can be used in industrial and biomedical applications.

Status

Some bolometric sensors are used in the metrology field, but bolometer arrays are predicted to be competitive with CCDs in the future particularly in the field of IR imaging.

Industrial partnership to reach the manufacturing stage is sought.

Ref. 373



INSTRUMENT FOR MEASURING PARTICLE FALL OUT ON SURFACES

Description

The original Particle Fall Out (PFO) instrument was developed around 1969. The application of this instrument was very successful in the aerospace industry. Later, a new (patented) PFO-instrument was developed because the original version suffered from alignment problems of both the light source, as well as of the condenser and of the two mirrors. The second model included some alignment improvements, but there were still four items to be aligned: After transportation of an instrument, re-alignment of the instrument was sometimes needed. The new design does not have the four adjustable items, the single light source is now replaced by 11 Light Emitting Diodes (LEDs) which are firmly fixed in a holder. This design guarantees a stable instrument without adjustable mechanical items.

A second reason for the newly designed instrument was to increase the measuring surface area from 15 mm² to 30 mm² using the same sample plate of 50 x 50 mm. The increase in surface area (by a factor of 4 in this case) was recommended for statistical reasons as the measured area of 15 mm² was seen as too small. The new version also uses a monochromatic light to cancel out fluorescent effects. A final design improvement was introduced by the exploitation of the latest technology developments in LEDs and electronics to provide added value.

A prototype of the PFO instrument with 11 LEDs has been operational during the last 6 years without any problems and the sensitivity has hardly changed during this time. The background detection limit was reduced because of the high intensity of light emitted from the 11 LEDs and because of the optimised optical design. This resulted in an improved detection limit of 3 ppm instead of the 10 ppm achieved with the older instrument. The inclusion of LEDs as the light source has made the instrument less sensitive to alignment problems during operation or transit.

Innovative Aspects

The originally patented PFO meter has been modified. The main improvements are:

- The single halogen light source is replaced by 11 LEDs, which are glued in the LED housing. This housing has 11 fixed holes at an angle w.r.t. the sample plate of 4° which was chosen because it resulted in the best outputs for two contaminated sample plates.
- The 11 LED's emit light with a beam width of $\approx 10^\circ$ and with a wavelength of 660 nm. The electronics limits the power level to roughly 1/4 of the maximum power in order to reduce ageing effects.
- The shape and surface finish of the optical housing, including the optical baffle, is such that the electronic output is a minimum for clean sample plates.

- A 30 mm diameter lens, located in the optical path condenses the light scattered from the sample plate towards the detector.
- An optical filter is only needed in cases where the effect of fluorescent materials is of interest.
- The detector in the prototype is a normal photocell, with high sensitivity in the blue region. For certain type of measurements, a CCD detector can be installed.

Application Fields

General clean-room use, e.g. class 1.000 to 100.000 for food, surgery, optics, medicine and semiconductor fabrication.

Status

The original Particle Fall Out (PFO) instrument was developed around 1969. A licence agreement was granted for the manufacturing, distribution and maintenance of this instrument. Now a new (patented) PFO-instrument has been developed and will be manufactured by the same licensee.

Ref. 374



COMPACT MULTI-COMPONENT TRACE GAS ANALYSIS SYSTEM

Description

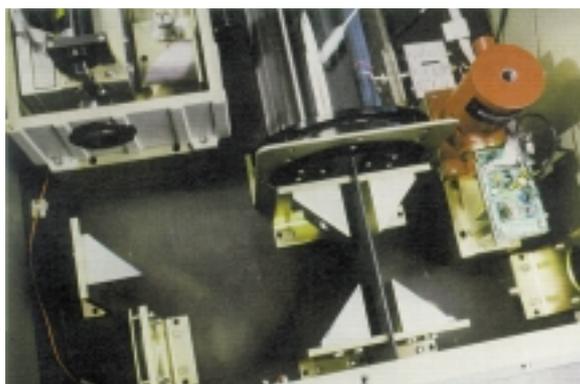
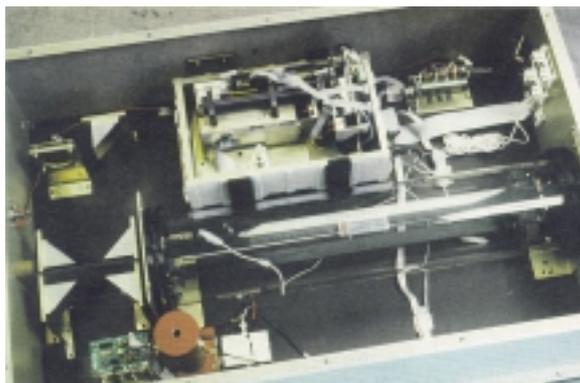
For the measurement of atmospheric trace gases, a Fourier Transformation Infrared (FTIR) spectrometer is used. The bulk optics measurement system consists of an IR source, several mirror systems, a HeNe reference laser, a modulator, a gas cell (10 m path length), an IR detector and data acquisition capability. Measurements are made in the spectral region area between 2 μm and 16 μm . The gas detection is achieved by evaluating specific gas absorption bands in the spectrum. The spectral features in the spectrum determines the gas type and the absorption relative to the 100% line can be used to quantify how much gas is present. Spectra generated from background gases (water, carbon dioxide, methane) and overlapping spectral lines need to be resolved computationally.

Complex software models have been developed for the simultaneous, multi-component analysis of 30 gases. The FTIR spectrometer can be adapted to operate under different measurement conditions, i. e. the new software models can be set up so that the system can be sensitised to measure specified gas combinations present in the measurement environment.

FTIR systems are already commercially available, but this technology approach offers a compact, rack-mounted, ruggedised, qualified and long-lasting system. The measurement system is equipped with a suitable mechanism for flushing the gas sampling cell after every measurement cycle. The system runs automatically, evaluating, with a temporal resolution of approx. 1 minute, the concentrations of the 30 target gases. For special cases like, for example, the measurement of gases with low detection limits, the system can be equipped with a gas cell having a longer path length.

Innovative Aspects

The compact, stable system set-up allows access to hitherto unapproachable areas and hostile surroundings. The measurement system consumes little power and is easily maintained due to its modular construction (service interval approx. 2-3 years). The quasion-line air analysis of approx. 30 different gases is carried out automatically (special semiconductor or polymer detectors can only detect single substances or substance groups and the detection is usually carried out with inferior sensitivity). Detection of single gas components down to ppm concentrations is possible. The system can be easily adapted to different environmental conditions (gas types, detection limits, conditions of integration, etc.)



Application Fields

- Workplace monitoring
- Closed room air analysis (e.g. submarine, airplane)
- Control of production processes.

Status

Joint ventures and/or the distribution of licences.

Ref. 375



MECHANICAL COMPONENTS

MAGNETIC DRIVE

Description

Meeting zero emission standards in the transfer of hazardous or critical fluids and gases is now possible through an efficient and economical high torque, high-RPM magnetic drive. Coupling mechanical power into sealed spaces while maintaining the integrity of the sealed space is a technical challenge of enormous proportions, especially where zero leakage is required in the pumping transfer or circulation of hostile fluids or gasses. The risk of dangerous leakage exists in any mechanically coupled pump housing and electric drive. The risk gets progressively higher as the dynamic (rubbing) seals or stuffing boxes wear with use.

Innovative Aspects

In traditional magnetic drive designs, the magnetic flux between the inner and outer magnets generates eddy currents in the stationary metal barrier, resulting in efficiency loss and barrier heating. The technology in question reduces such losses to three percent of transmitted power. This is accomplished primarily through the use of specially laminated barriers.

The drives accept very high torques and are suitable for use with large pumps. Power loss is low and the heating effect is greatly reduced.

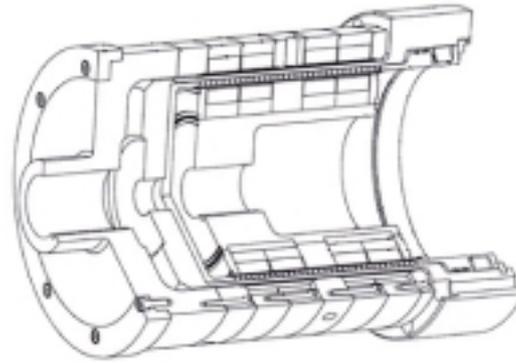
Application Fields

The drives are suitable for use in specialised nuclear, chemical, medical, military, marine and pharmaceutical applications. They are intended for any application where dynamic seals are not acceptable for safety or other reasons.

Status

The drives are fully developed. Joint ventures and licence agreements are sought.

Ref. 376



LONG-STROKE PIEZO ACTUATORS

Description

Long-stroke Piezoelectric Actuators have been developed for space use. They offer compact, innovative solutions for micro-positioning on long strokes (from 1nm up to 100 mm) and for generating, controlling or damping vibrations.

These actuators use European low voltage piezo ceramics, requiring 200 V in DC mode and less than 10 V in AC resonant mode). They can be classified under the following three categories :

- **Direct Piezo Actuators (DPA)**
The most simple actuators are DPAs. Typical characteristics of a DPA are high stiffnesses, high forces (> 3 kN), overall deformation of about 0.075% and displacements limited to about 100 microns.
- **Amplified Piezo Actuators (APA)**
A first alternative to overcome this last defect consists in using APAs. This concept offers much larger deformation (up to 1%), leading to much larger strokes, but keeping high forces. For example, the APA100S produces a displacement of 100 µm and a blocked forces of up to 20 N, with only 10 mm in height. The APA500L produces a displacement of 500 µm and a blocked forces of up to 500 N, with only 55 mm in height.
- **Linear Piezo Motors (LPM)**
This alternative is based on an ultrasonic piezo motor, which uses a combination of electro-mechanical and frictional forces, in order to achieve a long stroke. Such motors do not require any power to maintain position and have infinite positioning resolutions. Their positioning precision can be very high (better than 1 nm) with adequate sensors. The LPM20-3 possesses an AC-stroke limited to 3 mm due to its elastic guiding (giving the advantage of no lubrication), and an actuation force of 20-30 N, a blocking force of 50-60 N. Other piezo motors for longer strokes and rotative motion have been developed upon request.

Innovative Aspects

The concepts used in APAs and in piezo motors are innovative compared both with DPA and with electromagnetic actuators. They offer much larger strokes than DPAs and exhibit both higher positioning capabilities and force/mass ratio than conventional electromagnetic stepper motors.

Application Fields

Domains of application include optics, space, aircraft, instrumentation, micro-electronics, electro-valves, etc.



Status

These technologies are being qualified by CNES. Application projects are running with CNES and ESA. Several patents are pending. A complete range of industrial piezo actuators is commercially available.

The company is looking for OEM and direct sales, distributors in different countries and partnership for new applications. Collaborations are sought.

Ref. 377



CAPILLARY-DRIVEN COOLING LOOP (CDCL)

Description

Conventional cooling loops used throughout industry are generally based on electrical pumps. The loop described here features a two-phase (liquid/vapour) fluid circulation which is driven by a capillary pump, thus avoiding the high mass, electrical power and induced vibrations of a conventional liquid pump. The loop is able to transport up to 1 kW over a distance of several metres. Due to the extremely small bore size of the capillary pump, heat transport against gravity is possible. The product has been primarily developed for zero-g applications in space projects. However, due to the latest advances in capillary pump technology, the device is generating increasing interest in the one-g regime of terrestrial applications.

Main elements of the loop are shown in the accompanying photograph:

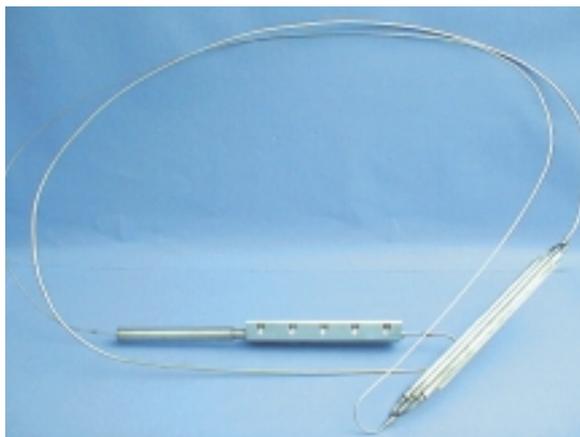
- Heat is transported between the "evaporator" as heat-input zone and the "condenser" as heat output zone. The capillary pump is an integral part of the evaporator. Condenser and evaporator are connected by flexible tubing for liquid and vapour flow.
- Heat evaporates liquid contained in the saturated wick structure of the evaporator. Vapour flows to the condenser and releases the heat of vaporization by phase change into liquid. Liquid is sucked back to the evaporator by the action of the capillary pump.

Innovative Aspects

- Independent system without external energy supply
- Passive system with long service life due to the absence of moving parts
- Low weight (no mechanical pump), small tubing diameter and fluid quantity
- Due to the flexibility of the transport lines the loop can be used in cases with low accessibility
- Easy adaptation to meet specific customer configurations
- CDCL has the potential, through miniaturization, to be used to cool electronic and computer units.

Performance data of the loop shown in the figure:

- Heat transfer over 2 m against gravity: 900 Watt
- Temperature difference evaporator/condenser: 10°C
- Operating temperature range: overall -75°C to +90°C
at max. power 5°C to +50°C
- Lifetime: 25 years



Application Fields

The product has been developed during the 1970's and successfully applied in several space projects. Typical terrestrial applications are:

- Heating or cooling of units in equipment racks
- Electronic and computer cooling
- Heating / cooling tasks in refrigeration and air conditioning equipment

Status

Product development according to customer specification, marketing.

Ref. 378



PRECISION MECHANICS AND OPTICS

SPOT – THE DOAS SYSTEM FOR TRACE GAS MEASUREMENTS ON VERY LONG OPTICAL PATHS

Description

SPOT is a remote-sensing system developed by the donor company for use in space. It analyses air composition, “exploring” a path of several kilometres in open atmosphere without the need to sample the air at a given site. The system has been designed to detect and measure a wide range of the most interesting pollutant gases, even in very low concentrations.

The SPOT system exploits the Differential Absorption Spectroscopy (DOAS) technique, featuring the capability to use ultraviolet-visible (UV/VIS) light absorption for the simultaneous detection of many substances over extensive areas. The absorption of light coming from a source over a path length of up to several kilometres is recorded and correlated with the spectral “fingerprints” database of the species under investigation, i.e. their absorption cross sections. The use of the UV/VIS spectrum allows the detection of many gases which do not absorb in the IR (e.g. homonuclear diatomic or some monoatomic substances).

The SPOT system consists of an artificial UV/VIS light source (Light Unit) on one side of the optical measurement path and a receiver (Spectrometer Unit) on the other side. The light unit consists of an optical module (O-LU), equipped with a shutter device, and an electronic module (E-LU). The spectrometer unit consists of an optical module (O-SU) and an electronic module (E-SU) which remotely controls the light source shutter for background measurement. Data from the spectrometer unit is transferred via a serial line to a PC dedicated to data storage, analysis and system management operations.

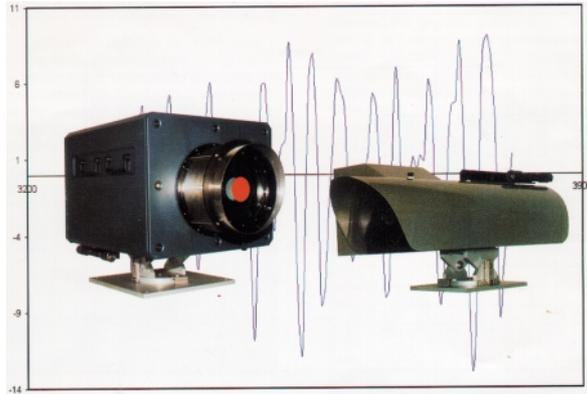
Innovative Aspects

The SPOT system has provided many innovative technical solutions, yielding the best possible results currently achievable in gas analysis based on the DOAS technique. The new optical design, the use of advanced optical materials, together with the use of high-resolution, high-accuracy solid-state array detectors, make SPOT a very high performance instrument capable of concentration measurement at very low levels, over path lengths up to 10 km.

Application Fields

SPOT is ideally suited for measurements in urban, rural and industrial areas. For example:

- urban air-quality monitoring
- traffic and highway monitoring
- airport air-quality monitoring
- rogue emissions
- waste disposal site surveillance
- rural environment monitoring
- background measurements
- measurements in inaccessible areas.

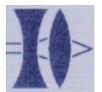


Status

The donor company’s product assurance policy is in accordance with the European Space Agency standards, and is certified ISO 9001.

The technology is patented and ready for marketing. Product sales are envisaged.

Ref. 379



ADVANCED ADAPTIVE OPTICS

Description

In ground-based telescopes, adaptive optics (AO) aims to compensate, in real time, for the wavefront distortion caused by atmospheric turbulence. AO is gaining in importance today because it is the only means to fully exploit new generation, large (6-10 m) ground-based telescope capabilities. On the other hand, the increased telescope collecting area requires both wavefront sensors and a deformable mirror with a high number of degrees of freedom (sensing elements and actuators), leading to highly complex and expensive systems.

The technology concerns a special AO system, namely the first implementation of AO directly on the secondary mirror of a telescope. The adaptive secondary design is based on a thin continuous face sheet mirror moved by electromagnetic actuators. Permanent magnets are glued on the mirror, while voice coils are connected to the support structure by cold fingers.

Electronic control boards are housed in small modular cooled racks that are placed close to the mirror. The control electronics uses DSP for the actuator control and sensor read out. Four DSPs (i.e. all the acquisition, control and driving units for eight channels) are assembled on one board (size 200 mm x 80 mm).

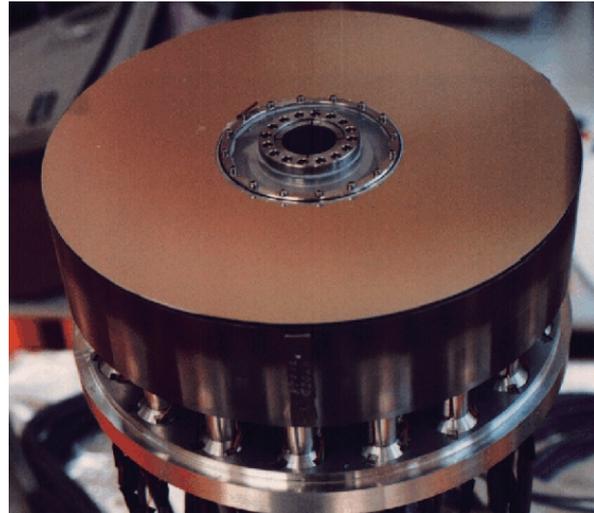
The communication interface has been designed to fulfil the speed requirements for real-time data exchange. Both the high, distributed computational power and the analogue electronics are designed to allow the achievement of the demanding performances in terms of both accuracy and time response. A library of software routines is provided to easily interface the adaptive mirror real-time control unit to the external control unit.

Innovative Aspects

A unique advantage of the adaptive secondary mirror is the ability to perform tip-tilt correction, which on current focal plane systems is implemented by auxiliary steering mirrors. Finally, the adaptive secondary can perform chopping for IR observations and can be used statically to correct low-order aberrations (active optics).

The use of voice coil motors allows to achieve the stroke (up to 0.5 mm) required to perform chopping and tip-tilt correction by using the deformable mirror directly. Moreover, the actuator cost is reduced by about one order of magnitude by using voice coils instead of piezoelectric devices.

Application Fields



Potential applications of adaptive optics can be identified in scientific instruments, industry and medicine. The technology could be mated with either fast actuators for dynamic compensation or with slow actuators for active shape control of lightweight reflectors.

Status

The first complete prototype of an adaptive secondary mirror has been delivered. The developer has also designed a second release of the same prototype, characterised by having an aluminium back plate instead of the previous glass one. This has been done to study a novel actuator design that is expected to give a gain factor of four in terms of system efficiency.

A 336-actuator, 642-mm diameter adaptive optics secondary is being designed and built for a 6.5 m diameter ground-based telescope.

Cooperation for the development of specific applications is sought.

Ref. 380



ELECTROFORMED OPTICAL MIRRORS

Description

Replication technology is the production of one or more objects by exactly copying the surface of a master. This process is used extensively in many forms. Metal replication involves electroplating onto the surface of the master or mandrel a layer of metal that is then separated by an appropriate method to form an entirely new object. The possibilities of this process are numerous and in principle any shape can be produced and any metal can be electro-deposited; the most common electro-deposited materials are nickel, copper and silver. For the production of any object by this method, the accuracy of the finished product depends upon both the original master and, more importantly, the replication process itself.

This technology has been applied with very good results to the production of grazing-incidence mirrors for X-ray telescopes having open and closed geometry, quasi-normal incidence mirrors for infrared astronomy and precision reflector antennae.

For the manufacture of the latter two products, a "sandwich" configuration (two electroformed skins with an interposed core made of epoxy resin or aluminium honeycomb) has been designed and tested in order to increase its stiffness-to-weight ratio, with the following results:

- Nickel-Epoxy-Nickel:
surface accuracy = $4.3\mu\text{m RMS}$ ($24.9\ \mu\text{m}$ peak to valley)
areal density = 8.8kg/m^2
- Nickel-A1 honeycomb:
surface accuracy = $8.8\mu\text{m RMS}$ ($55.6\ \mu\text{m}$ peak to valley),
areal density = $4.2\ \text{kg/m}^2$.

Innovative Aspects

Replication using the electroforming process is a mature technology, but its potential in terms of dimensional accuracy of the finished products been demonstrated only recently, due to the much improved process control.

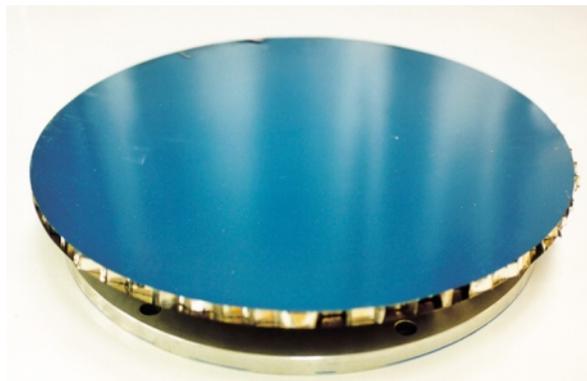
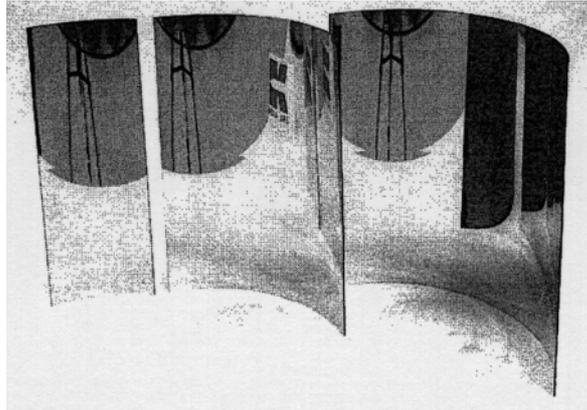
Application Fields

Opportunities exist in the manufacturing of the following items:

- X-ray grazing-incidence optics
- X-ray concentrators
- high-accuracy reflectors and reflectors panels
- complex-geometry components.

Status

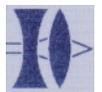
This technology has been successfully applied for the production of X-ray grazing-incidence optics for several X-ray telescopes, quasi-normal-incidence



mirrors for infrared astronomy, and for the manufacturing of precision reflector antennae that will operate in the 30-900 GHz range.

Production of electroformed parts for specific applications is offered.

Ref. 381



ADAPTIVE OPTICS SYSTEM FOR IMAGE CORRECTION

Description

Adaptive optics is a technology which was developed to ameliorate the distorting effects of the Earth's atmosphere on telescope images (commonly viewed as "twinkling"). It was developed by both the defence and astronomical communities. Imaging of orbiting satellites and the propagation of laser beam both suffer from aberrations introduced by the atmosphere. Images of celestial bodies are similarly blurred by a factor of typically 40. An adaptive optics system corrects the incident light in real time in an imaging system before it is recorded by the detector.

The University responsible is the home of the UK's Astronomical Adaptive Optics Programme, which aims to equip the 4.2 m William Herschel Telescope in the Canary Islands with a feed-through adaptive optics system (called NAOMI). The system consists of an adaptive mirror to correct the wavefront, a wavefront sensor used to measure the aberrations, and a real-time control system. The group has already built a low-order system for the same telescope called MARTINI.

More recently, the group has become interested in the industrial and medical applications, e.g. in medical imaging or industrial laser control.

The NAOMI adaptive optics system will produce images which are typically 8x sharper than the uncorrected ones. The images will have diffraction-limited widths and a Strehl ratio of 0.65 in the infra-red (2.2 microns).

Innovative Aspects

The university adaptive optics group has particular expertise in the use of liquid-crystal devices as wavefront controllers. These are non-mechanical phase modulators which are used to remove or induce optical aberrations.

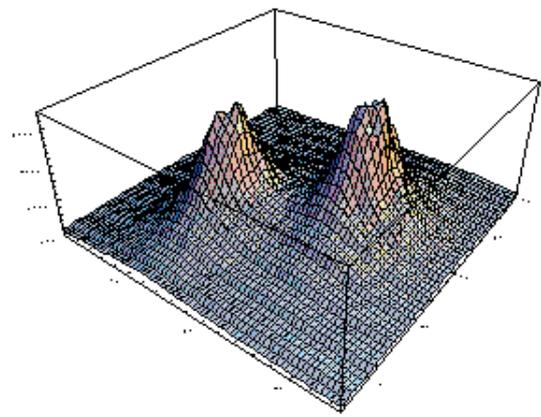
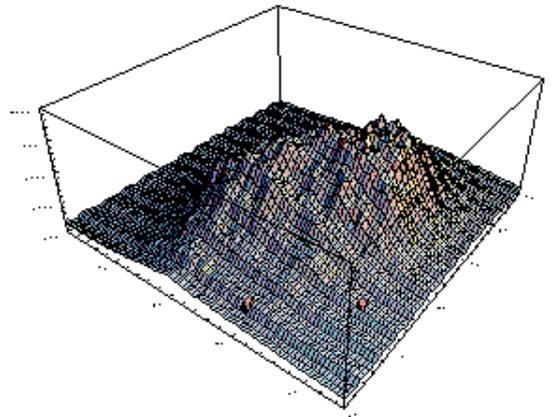
Application Fields

Adaptive optics has applications in high-power laser systems, medical imaging, optical storage, and microscopy. The state-of-the-art technology being developed for adaptive optics systems has applications in image processing, optical testing, high-speed photography, and real-time control. Similar technology is already being used in camcorders and binoculars, where hand-held vibrations are removed.

Status

The organisation seeks non-space development opportunities in related fields such as those listed above.

Ref. 382



CRYOCOOLER-RELATED TECHNOLOGIES - HIGH-TOLERANCE CLEARANCE SEALS (MICRONS) MAINTAINED BY BERYLLIUM COPPER DIAPHRAGM SPRING.

Description

A novel range of cryocoolers developed for use in space allow temperatures of between 4 and 80 K to be reached by purely mechanical means. Special technology subsystems developed to construct the coolers are likely to find uses outside the cooler field and some of the core components are listed below. Space cryocooler systems are thought to be too expensive for terrestrial applications, but low-cost coolers in the \$ 2000 price bracket are thought possible for future high-volume production runs.

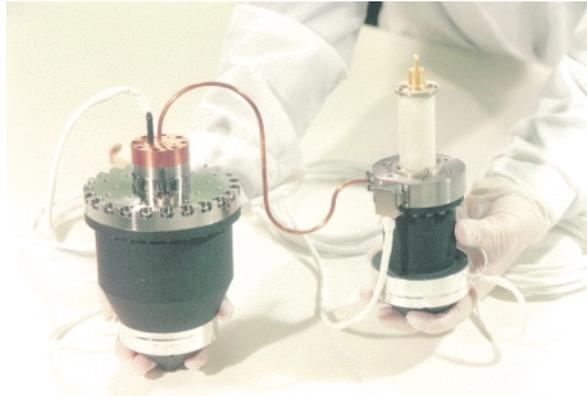
Features

- A novel beryllium copper diaphragm spring design which allows one degree of freedom motion with zero sideways movement. This permits piston/cylinder gas clearance seals to be produced, for example, with clearances in the order of microns. This diaphragm spring could lend itself to other application areas such as long-life pumps for human heart implants.
- A micron machining and assembly capability has been developed to allow the fabrication of cryocooler structural components. The capability to repeatedly manufacture and assemble components to micron tolerances is applicable to other areas such as the electro-optic instrumentation and sensor equipment fields. Precision mechanical components are also used in many other areas such as space mechanisms.
- Other technological elements include metal 'O' seals to achieve hermetic gas sealing .

The data below illustrates the benefits to cryocooler performance derived from the technology elements described above.

The technical parameters for the 50-80 K space cryocoolers are as follows:

- Long life achieved by ensuring no contact of moving parts, eliminating friction and wear
- Long life by using diaphragm springs operating at low stress and infinite fatigue life
- Long life by achieving extremely small helium gas leakage (1 atmosphere in > 1000 years)
- Operating frequency is 44 Hz \pm 1 Hz (variable for other cooler types)
- Compressor input power is 50 W maximum
- Cooling power at 65 K = 1100 mW
- Cooling down time less than 60 minutes
- Ongoing life testing demonstrates life of greater than 55,000 (6.3 years)
- Rugged design capable of surviving space launcher



vibration and shock loads.

Innovative Aspects

The novel clearance seal technology maintained by diaphragm springs and the know-how surrounding fabrication is highly specialised. The micron machining and assembly capability offers unrivalled ability to manufacture precision components to ultra-high specification levels.

Application Fields

The technologies may be suitable for potential use in the following areas:

- Heart pumps
- Precision mechanics
- Mechanical coolers for computer chips and low-cost ground-based applications
- Precision space mechanisms.

Status

Clearance seal technology and micron machining and assembly capabilities are available for non-space application and for possible participation in EU R&D projects.

Complete space cryocooler system products are available covering the range 2.5 K to 100 K. A programme could be initiated for the development of a low-cost cooler for ground applications such as supporting the emerging telecommunications high-temperature-superconductivity opportunities.

Ref. 383



MID TO FAR INFRARED INTERFERENCE FILTERS

Description

The donor company was created in 1993 to satisfy increasing demand for custom designed and manufactured filters operating in the 2.5 - 40 μm waveband. A strong capability, built upon expertise developed previously at Reading University, arose from the need to satisfy IR filter requirements in a broad range of industrial and research applications. Early examples in space included the Stratospheric Aerosol Measurement (SAM II) on Nimbus 7, the Long Duration Exposure Facility (LDEF), the Photopolarimeter-Radiometer (PPR) on Galileo, and the Stratospheric Sounding Unit (SSU)/Television and Infrared Observation Satellite (TIROS). More recently, this substantial multilayer coating design and manufacturing expertise has been used successfully with the VISIR instrumentation on the European Southern Observatory Very Large Telescope (VLT) facilities at La Silla in Chile. Current work involves filters for a joint University of Arizona/Ball Aerospace project. IR filters have also been applied to ground-based applications such as protection against laser-beams, precision gas detection and thermal imaging.

Typical filter substrates are germanium and silicon, but also include cadmium telluride, sapphire and zinc sulphide/selenide according to the application. The coating process evaporates materials from resistive molybdenum boats within a vacuum chamber. Typically, 10-20 layers are deposited with optical thicknesses corresponding to quarter-wavelengths of the wavebands to be transmitted or rejected.

A leaflet can be provided that summarises filter types that the company produces. Band-pass filters typically have a 1 - 5% half-peak-height bandwidth. Filter performance is measured using Perkin-Elmer type 580B infrared spectrometers. Coating thicknesses range typically between 10 and 15 μm . Initial coating design is carried out using FILMSTAR and CYCLOPS software, developed in the USA and at Reading University, respectively. Coated-area diameters can range up to 50 mm.

Innovative Aspects

The flexibility of the company's approach to meeting customers' special needs is based on only producing filters to order. No catalogued items are held in stock. This enables the company to concentrate on supplying exactly what individual users require. Other manufacturers offer standard items that may not necessarily satisfy these special needs. The UK subsidiary company addresses customer needs in the mid- to far-infrared spectroscopic region. The US parent company can supply custom-produced filters to cover the optical spectrum from 190 nm to 6 μm .



Application Fields

- Remote sensing
- Thermal imaging
- Thermal surveillance
- Analytical instrumentation
- Defence
- Fibre optics/communications
- Astronomy
- Machine vision
- Medical instrumentation
- Process control
- Space.

Status

The company can satisfy most likely filter requirements. The company seeks to become more closely involved in applications of its products through collaborative, multi-partner research projects supported by the European Union BRITE/EURAM programmes and the UK DTI Link programme. The company welcomes news of opportunities that may arise in these areas.

Mid- to far-infrared interference filter expertise has been accumulated over the past 35 years. An immense inventory of knowledge and skill acquired over this period is available to enable customers to obtain the very best filter performance.

Ref. 384



3D PARTICLE TRACKING VELOCIMETRY

Description

3D Particle Tracking Velocimetry (PTV) is a technique developed to determine 3D velocity flow fields. It is based on the visualisation of flow fields with small, neutrally buoyant particles and recording stereoscopic image sequences of the particles. An on-site calibrated convergent multi-CCD-camera set-up (usually four cameras) images the particles in discrete time steps. A/D converters digitise the analogue image signal. By applying threshold and high-pass filtering, errors due to reflections are reduced. The co-ordinates of the particles in the 2D image are determined with sub-pixel accuracy using the grey value weighted centre of gravity. The calibration of the parameters of the photographic model, e.g. for the camera orientation, enables the particle correspondences between the different images of each time slot to be established. By establishing correspondences and the parameters of the model, the 3D co-ordinates of the particles are computed. Using four time steps, the particles are tracked through the time domain reconstructing trajectories of arbitrary length. 3D velocity vectors and trajectories in a 3D observation volume can be used for analysis and interpretation of the flow field. Eulerian and Lagrangian flow properties can be derived from the data sets.

Innovative Aspects

PTV is a truly 3D technique (all three components of the velocity fields are determined in a 3D observation volume). As a result, 3D vector fields for Eulerian analysis plus 3D trajectories for Lagrangian analysis are delivered. Currently, a new image-space-based tracking method using the epipolar line constraint will be implemented to achieve a higher spatial resolution and longer trajectory.

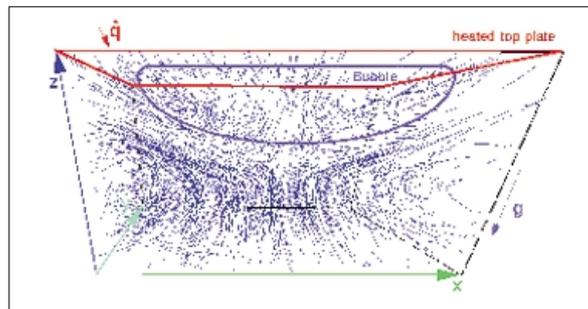
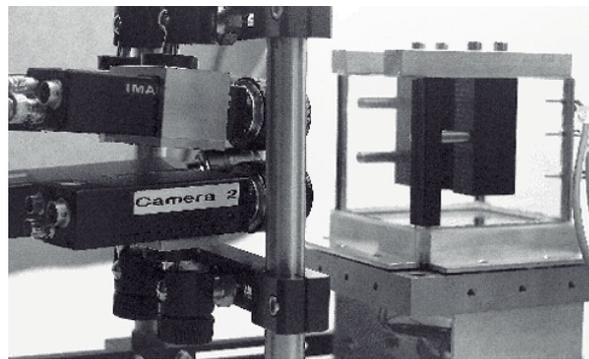
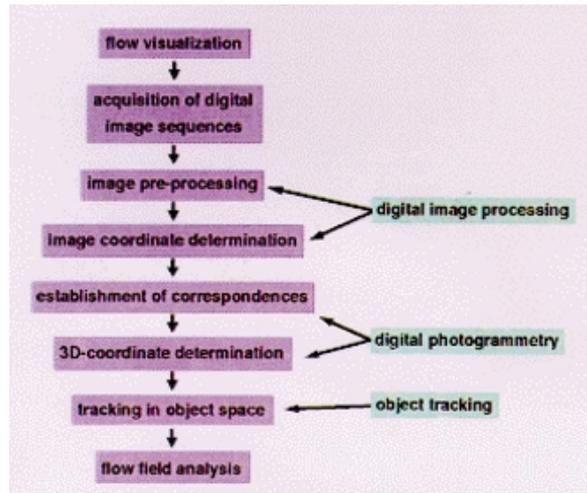
A possible hardware set-up based on 4 CCIR-norm. CCD cameras (digitised to 512 x 512 pixels) is capable of tracking up to 1000 particles. The relative accuracy of the three-dimensional velocity vector is 1:4000 of the field of view. The temporal resolution is given by the camera type which is used to acquire the image sequences (normally 50 or 60 Hz with a standard video camera).

Application Fields

Current applications of 3D PTV are flow separation, turbulent channel flow and dispersion, thermocapillary convection, fluid column and mixing.

Status

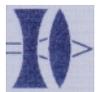
Studies on the applicability of 3D PTV have already been made (for example, surface-tension driven convection, Marangoni convection, measurement in liquid columns).



The hardware set-up, which consists of three CCD-cameras, RGB-framegrabber, illumination and storage unit, can be built in 3 months. The software for particle tracking is operational.

Co-operation and collaborative ventures are welcome.

Ref. 385



COMMUNICATION

SYNCHRONOUS DIGITAL HIERARCHY (SDH) SATELLITE MODEM

Description

The SDH Satellite Modem consists of the following parts:

The Satellite Modulator/Framer and the Demodulator/Deframer. The SDH satellite modem allows transmission of 155.52 Mbit/s over a 72 MHz satellite transponder. The combination of the modulator and the demodulator gives excellent BER performance and synchronisation. A very robust synchronisation method is used for carrier, clock, decoder and deframer.

Many system parameters are monitored. The E_b/N_0 indication is quite unique for its accuracy and large dynamic range (6-20 dB), which allows a very good estimate of the available link margin in the earth station.

All control and monitoring parameters are available and remotely accessible via RS485 interfaces (or RS232). Summary alarm contact outputs are available for station alarm monitoring.

Features

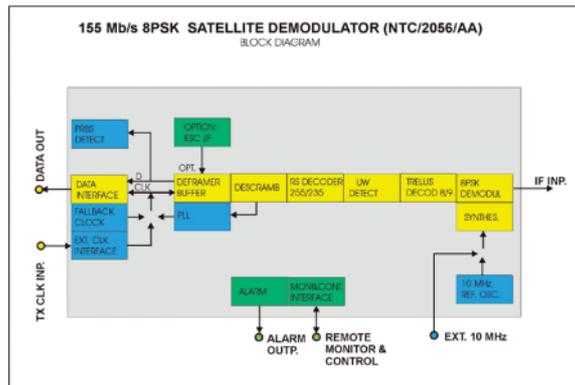
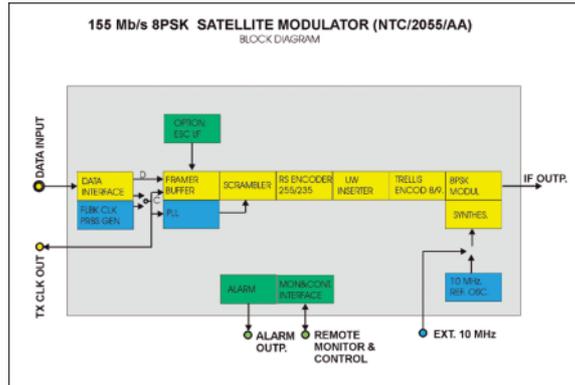
- Specially adapted for B-ISDN, SDH (SONET) and fibre network restoration
- Rate: 155.52 Mbit/s (139.264 Mbit/s optional)
- Bandwidth requirements: 72 MHz transponder
- 6D-Trellis coder + Reed Solomon outer coder
- Excellent BER performance
- BER = $1E^{-9}$ for $E_b/N_0 = 8.0$ dB (measured)
 - Robust synchronisation
 - Internal PRBS generator & detector
 - Local & Remote (RS485) monitoring & control
 - Very compact (height: 17.6 cm !)
 - Highly reliable design
 - Low cost.

Innovative Aspects

The outstanding performance of the SDH Satellite Modem means no spectrum equaliser is required.

Application Fields

The SDH Satellite Modem offers excellent performance. The equipment has been used in cable restoration applications. Interest has also been generated from Service Providers who view the technology as offering an alternative solution for the transmission of complete program "bouquets" of 155 Mb/s into a 72 MHz transponder. In addition to the standard G703, an optical interface has also been made available to some specific customers.



Status

The technology donor is interested in selling licenses to operators in the Internet, TV or tele-communication fields.

Ref. 386



RADIO FREQUENCY (RF) DIGITAL REMOTE CONTROL

Description

The advantages of this approach to RF remote control compared with the more usual infrared technology, are linked to the good propagation properties of radio waves even if the receiver is not precisely in the field of view of the transmitter. This equipment was derived from a need to measure very-low-level emitted electromagnetic fields, a prerequisite being not to interfere with surrounding equipment. The product is designed for special environments such as a Space Station.

The ability to communicate at a very low power emission level (Emitted Field lower than $40 \mu\text{V/m}$ @ 1 m) was achieved using a highly sensitive receiver over a practical range of 15 m. The very fine selectivity of the receiver guarantees good reliability and safe use.

It is possible to select the frequency of the channel used in steps of 25 kHz within the range 430 to 435 MHz. In addition, the use of a digital signal provides a very simple method to generate different codes on the same channel, each of them matching a specific command.

Finally, the small size of the equipment ensures that it is easy to carry.

Innovative Aspects

Main Characteristics:

Frequency	430 to 435 MHz
Modulation	Phase
Operating Temperature	-10°C to $+55^{\circ}\text{C}$
Practical Range	≈ 15 m

Transmitter:

Frequency	Programmable
Emitted Field	$< 40 \mu\text{V/m}$ @ 1 m
Power Supply	5 V
Sleeping Consumption	$< 50 \mu\text{W}$
Operating Consumption	165 mW

Receiver:

Frequency	Programmable
Sensitivity	-120 dBm @ 1% BER
Selectivity	-70 dB
Bandwidth	$\approx 3 \text{ kHz}$ @ 1.5 radian
Consumption	$< 40 \text{ mA}$
Power Supply	8 at 15 V

Application Fields

This equipment can replace infrared remote control, which does not guarantee sufficient reliability because of the problematic necessity to adjust the direction of the emitted beam to intercept the receiver.



RF digital remote control replaces wire connections to guarantee good reliability in the transmission of the signal, but leads to practical difficulties in terms of mobility and independence between emission and reception (for example with astronauts in a state of weightlessness).

Status

A complete system has been realised, tested and validated. The product can be modified to meet customer-specific requirements.

Ref. 387



FIBRE-OPTIC MULTICHANNEL VIDEO TRANSMISSION (VLINK)

Description

VLINK is a uni-directional video transport system with the capability of digitally transmitting high quality video channels and high-quality audio channels on a single monomode optical fibre. VLINK is based on a digital high-speed multiplexing technique which guarantees high system reliability. The system can be configured for different distances, the simplest version reaching up to 80 km without repeaters. Longer distances can be catered for with custom configurations.

The VLINK System is composed of a VLINK Tx unit, a VLINK Rx unit, and monomode optical fibre as transmission medium.

Video Transmission:

VLINK transports each baseband analogue video signal as a digital signal, and therefore with minimum degradation. All analogue video channels are digitized with 10 bit linear resolution and no compression is used, providing a high-quality video transport service. The sampling frequency and initialising filters used in the analogue interface makes it possible to transport baseband video signals with bandwidths of up to 5.5 MHz. The system can accept any of the most commonly used standards (PAL, NTSC, SECAM) or scrambled video signals. The clamping circuit of each input interface can be disabled, making it possible to transport any (non-video) analogue signal within the specified bandwidth, and dynamic range.

Audio Transmission:

The audio signal is transported as a 16-bit digital signal, with 20 kHz bandwidth. The A/D conversion is linear and no compression is used.

System Supervision:

VLINK provides continuous monitoring of unit parameters like power-supply voltages, received optical power and data link status, raising an alarm if any parameter goes outside the specified margins. Units are available fitted with external connectors for remote monitoring.

Features:

- 8 BB multistandard video inputs or/and 4 SDI digital video signals
- 32 BB audio inputs
- Power consumption: 160 W
- Total size: 19"/6U (incl. redundant power supplies)



Receiver unit



Transmitter unit

Innovative Aspects

Advantages of the proposed solution can be summarised as follows:

- Low cost
- Digital multiplexing for analogue and digital channels with studio quality
- Modularity of the concept that guarantees that the failure of one interface board will not affect the functionality of the rest of the unit
- System reliability with very-high-level electronic integration.

Application Fields

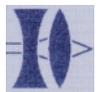
Fibre-optic multichannel video transmission has commercial exploitation potential in:

- related audiovisual (digital TV, cable, etc.) applications
- traffic monitoring and control
- defence and security.

Status

The product is in a marketable phase. VLINK was developed to meet batch processing requirements, which makes it very competitive in today's market. System reliability has been driven by space compliance requirements

Ref. 388



DISTRIBUTED INFORMATION SYSTEM WITH WIRELESS IR/LASER COMMUNICATION

Description

A control subsystem was designed for the space project MEDEX to control on-line stimuli generated from, for example, a pressure cuff or an ergometer, according to complex functions derived from various actual physiological parameters as measured by different instruments.

By considering the demands of the investigators and the conditions in orbit, the following main features of the architecture were fixed:

- a distributed system capable of time-correlated data acquisition
- system of one master and several slaves, strong master-slave coupling, fixed time slots
- wireless communication (IR-based).

For the MEDEX project, a flexible system of data processing was defined, designed, produced and implemented. The system consists of:

- IR/laser transceiver
- slave controller
- multiplexer
- PCMCIA card.

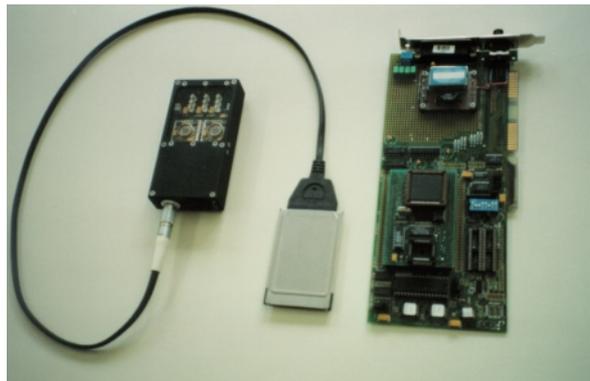
The transceiver sends and receives IR or laser radiation. The interface between transceivers and the other parts of the system is via TTL signals. There are no protocol constraints.

The slave controller - one for each slave device - unites the electronics for the communication task and the process interface. The slave controllers have their own microprocessor and adequate process periphery. They are able to meet a lot of control demands of connected medical devices.

The processor-controlled multiplexer is at the heart of the system and always the master of the system. An independent timer ensures the exact timing. A PC communication link can be established via a dual-port RAM. The PCMCIA card can work either as a slave or as the master. It also has its own processor and timer.

MEDEX arrangement:

In the MEDEX system, 9 medical devices and 2 stressors, a central unit and a laptop with PCMCIA card work together. The central unit contains a PC with the multiplexer. All experiment data are collected on the PC's hard disc. The laptop works as the user interface and contains special control software for experiment scheduling. All components are connected either by cable or by IR bus.



The system cycle time is 40 ms. This time is divided into 11 slots. Depending on the amount of data to be transmitted, the slot time varies from 2 to 7 ms. The data transmission rate is 1 Mbit/s.

The protocol used is CSMA. In the system only one peer-to-peer connection is active at a time.

Innovative Aspects

Data acquisition and control of distributed systems without time declinations in long-term experiments

Application Fields

The system can be useful for on-line data processing in distributed systems in which rather large amounts of data must be exchanged between many nodes using wireless communications.

Examples:

- data transmission from and to vehicles
- data collection and stressor control for human medical research or experiments with animals
- as an alternative to expensive installation of communication cables.

Status

All kinds of cooperation are sought.

Ref. 389



STORAGE SYSTEM FOR HIGH DATA RATES

Description

The high-speed-data storage system is a further development of the system developed for the spaceborne radar systems SIR-C/X-SAR. The core of the storage system is a full-length PC ISA card. The ISA interface to a standard PC is only for control and monitoring purposes. The data to be stored is accepted via a 32 bit wide TTL input interface. The peak input data rate is up to 40 Mbyte/sec. A 48 Mbyte data buffer is used to decouple the timing of the incoming data from the storage system.

Standard SCSI hard disks are used as the storage medium. They are mounted in a special housing incorporating vibration protection and the necessary power supplies. A housing is normally dimensioned for up to 8 disks which, with the presently available disks 18 Gbyte disks, provides a total capacity of 140 Gbyte.

An extension of the storage capacity is easily possible by means of additional disks in a larger housing (up to 15 disks = 262 Gbyte) or by using other disk systems.

By means of an Ultra-Wide Single Ended SCSI bus and an optimised data distribution technique, a continuous data storage rate of 32 Mbyte/sec may be achieved. The software for control and monitoring of the storage system is written in standard C modules and may be easily incorporated by the user.

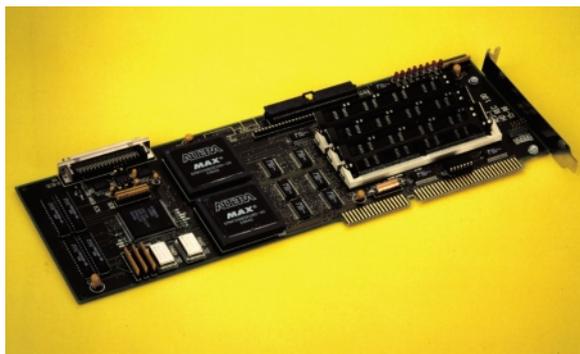
The data written to the disks may be copied to magnetic tape so that the disks can be used for subsequent storage of new data. A transcription system based on a Quantum DLT (Digital Linear Tape) tape drive is available for archiving stored data. A user-friendly software module is also available for reading tapes so that further, automatic processing of archived data is possible.

A prototype storage system has been in operation since August, 1996 and has been used in Europe, Asia and Latin America under various extremes of environment such as atmospheric pressure, humidity, temperature and vibration.

Innovative Aspects

The storage system is characterized by:

- compactness
- high data rate
- simple integration in given systems
- expandable storage capacity
- low cost.



Application Fields

Possible applications are data-acquisition systems with high-data-rate requirements, for example in connection with radar systems and photography.

Status

The donor is interested in sale of the system. Further development and adaptation can be offered.

Ref. 390



SATRE – SATELLITE TIME AND RANGE EQUIPMENT

Description

The system is based on the development of a largely autonomous highly precise spaceborne instrument for ground-station tracking for geodesic applications. The instrument's design has also been used to develop ground-based commercial equipment. There are three different functions depending on the instrument configuration chosen:

- Satellite orbit determination
- High-precision time dissemination via satellite
- Highly precise time synchronisation of communication networks.

The Spread Spectrum Technology has been optimised to operate independently of the primary user's transponder traffic, as a secondary user, without interference to the primary service.

A single unit can determine the distance between ground-station and satellite. Three units, placed at different locations, can determine the precise orbit position by using trilateration measurement. With one unit at each clock location, the system allows the comparison of two remote clocks independent of the distance in-between. With the Two-Way Time Transfer method, errors caused by the propagation path are eliminated. 'Synchronisation of communication network' provides an unlimited number of users with time synchronisation from the master-station with the highest accuracy.

The instruments are equipped with simple interfaces and can be easily connected to existing ground stations. Complete systems for use independent from the main-user of the satellite can be remotely installed. Each instrument consists of a transmitter- and a receiver module, as well as additional control units. It is equipped with an LCD-display and several configurable interfaces for data output and remote control. Network connection and control functions for additional equipment are available. Different frequency standards are available for different applications:

- VCXO
- SC-Cut high-performance crystal oscillator
- Rubidium standard.

A GPS-Time receiver for local time-stamping can be included as well. A redundancy option with two instruments is available too.

Innovative Aspects

Based on Spread Spectrum technology and low output power, the system can be used for different applications without interference to the main user of a satellite transponder.



The system is already successfully installed under the following configurations:

- Analogue TV Signal
- Digital TV Signal
- TDMA
- Free Transponder.

The high flexibility as well as the small size of the unit are additional benefits.

Application Fields

Four satellite orbit determination systems have been built, which work absolutely independently of the transponder user and absolutely independently of the main users ground-station. The generated data is almost real-time orbit information and ready for on-line processing. For time comparison and highly precise real-time time synchronisation with nanosecond accuracy, different chip rates and codes are available. Internal system-calibration routines as well as overall station calibration are available too.

Status

The donor's interest lies in the world-wide sale of instruments for existing services as well as the installation of complete systems for new applications.

Collaborative ventures that further the development of SATRE to meet customer-specific applications are welcome.

Ref. 391



ELECTRONICS, OPTOELECTRONICS

PELTIER CONTROLLER

Description

The cooling of electronic components and subsystems constitutes one of the more critical aspects in the realization of scientific experiments in microgravity; the necessity to avoid moving parts (pumps, fans) and coolants has resulted in a more diverse range of applications based on the Peltier effect. This thermo-electrical effect is based on the temperature variation which occurs in junctions of different materials (metals, semi-conductors) under a voltage difference. The thermal effect is high and is directly proportional to the electrical current.

This is a mature technology with design efforts concentrated on realizing high-efficiency power sources (Peltier Current Source - PCS) coupled with high resolution control of the set-point, good immunity to noise, thermal protection, protection against shorts and open circuits, optimal response in frequency, and the ability to accept a variable load.

The donor company has acquired considerable know-how in the development of Peltier controllers for space applications. The system configuration includes a control unit interfaced with the power bus (28 Vdc). The system has an opto-insulated control unit (analogue, parallel or serial digital), and a modular unit for Peltier powers from 25 W to 200 W.

Innovative Aspects

The innovative aspects of the technology with respect to the state of the art are:

- high efficiency
- high resolution in the control of the set-point
- good immunity to noise
- optimal response in frequency
- ability to accept a variable load.

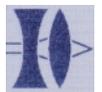
Application Fields

The know-how developed by the donor company in realising Peltier control units for space missions can be exploited in several industrial applications, in particular where requirements for accurate thermal control of electronics are concerned.

Status

On behalf of ESA, the donor company has realised several Peltier control units for different payloads (Biobox, Momo, Fluidpac, Gabriel) that have been flown both on Russian Vectors and on SpaceLab. The donor is interested in transferring its know-how to non-space applications and in cooperations for specific applications.

Ref. 392



CENTRIFUGE CONTROLLER

Description

The execution of biological experiments on board spacecraft often requires the presence of a centrifuge to simulate gravity, enabling a comparison to be made with terrestrial results achieved under 1 G conditions. The donor company has realized sophisticated electronic equipment (Centrifuge Control Electronics - CCE) supplied with 28 Vdc, which controls the rotating speed of the centrifuge with an accuracy of better than 1%.

The CCE is composed of a power-supply section (filters, DC/DC converter), a control section (micro-processor, FPGA, PWM, housekeeping), and a power section (motor drivers), giving the system extreme flexibility and reconfigurability. By means of a test connector, it is possible to load the firmware on an EEPROM, or to load the configuration table with the specific parameters of the PID and the speed set-point.

The system is equipped with an over-speed controller that is software driven. Furthermore, the system has start and stop commands, and makes the speed signal available in digital or analogue format.

Innovative Aspects

The following features are well beyond the state of the art:

- high reliability and accuracy in the control of the speed (better than 1%)
- low energy consumption
- flexibility and reconfigurability
- possibility to have a digital or analogue speed signal.

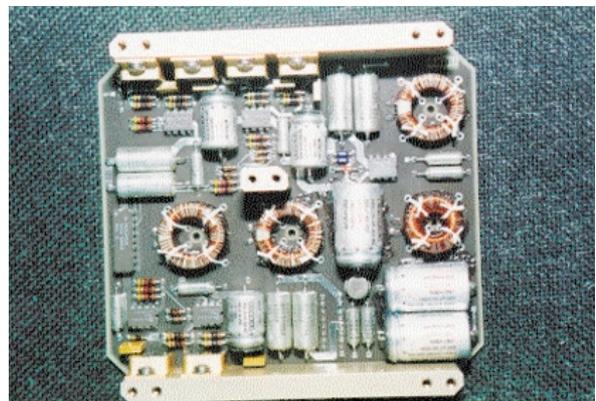
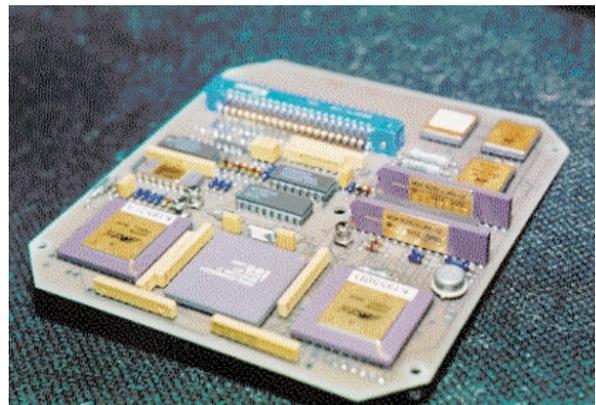
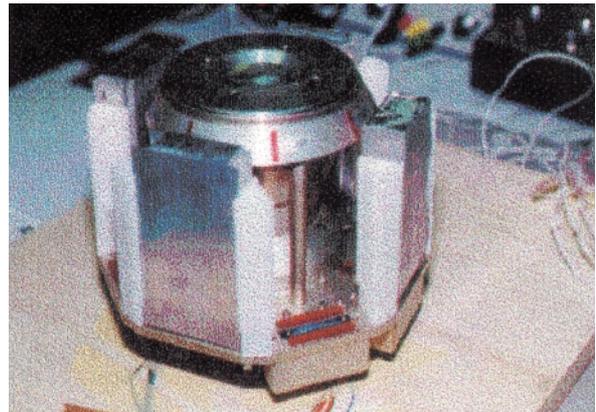
Application Fields

The control unit of the centrifuge has been developed to meet the exacting requirements of the space industry, with in particular high reliability, low weight and power consumption. The concepts developed could also find applications where rotational speeds have to be accurately controlled, for example in scientific experiments.

Status

The CCE has been developed under an ESA contract and has flown several times with BIORACK and BIOBOX. The company is interested in co-operating with companies interested in exploiting the know-how outside the space domain and co-operation in the development of customised controllers.

Ref. 393



ASIC - DATA COMPRESSION

Description

This is a new data compression ASIC offering bit reduction while maintaining data quality in terms of resolution and dynamic range.

The ASIC for data-rate reduction was originally developed for SAR remote-sensor applications. A SAR system generates a large amount of data, the size of which depends on parameters such as resolution and coverage area. The bottleneck in these systems is normally the data link to ground, where large data volumes require a powerful down link. If data is not transmitted on-line to ground, it is stored temporarily on-board for transmission later to a ground station, for processing. This requires a large and costly on-board storage capability.

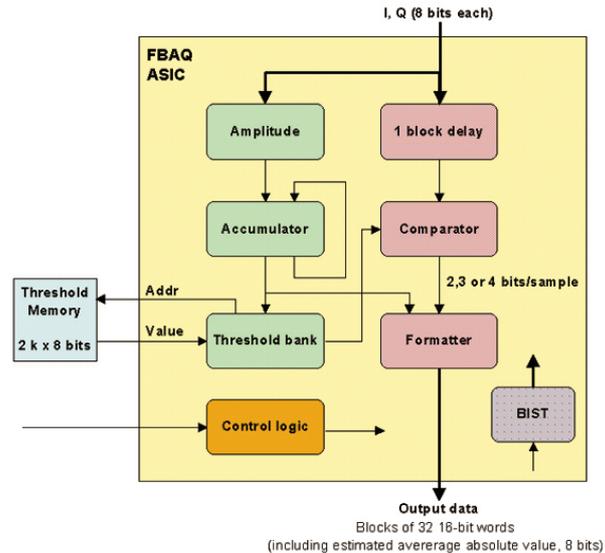
The newly developed ASIC, carrying a Flexible Block Adaptive Quantization (FBAQ) algorithm, was developed in Sweden and Canada. The compression algorithm is a minimum square lossy algorithm, which was devised in Canada. The algorithm was developed in France and implemented in Sweden.

Data compression is accomplished in the following way. The rms value of the incoming 8-bit samples over a predefined block is calculated, from which new thresholds are generated; how many depends on the working mode. Each 8-bit sample is then matched to the new thresholds and the sample is represented by means of a new set of mode-dependent bits. The new thresholds are set to minimise the introduced new quantization noise (maximum likelihood). By this means a lower bit rate is achieved and the link requirements can be reduced. The ASIC can be used for any gaussian data set with slowly varying rms value (e.g. SAR data). The set of thresholds used for each mode has to be transferred to ground for the reconstruction of the original samples.

The ASIC contains a Built-In Self Test (BIST), which can be activated at reset. The BIST incorporates the threshold memory as well as the compression functions.

H/W outline:

Input sampling rate:	19.2 MHz (used in the specific SAR)
Input data format:	I and Q, 8 bits each
Number of gates:	≈ 18 kgates
Package:	Ceramic Quad Flatpack, 100 pins (≈20 x 20 mm ²)
Manufacturer:	French
Technology:	CMOS rad tol. composite array, 1.0 μm
Power Dissipation:	≈ 1 W



Innovative Aspects

The raw radar data has 8 bits/sample for each one of the orthogonal components I and Q. The innovative idea for this ASIC is to represent each sample by a flexible, but lower number of bits with as little additional disturbance as possible (quantization noise). The ASIC can operate in 5 different modes, compressing from 8 bits/sample to 4, 3 or 2 bits/sample. The remaining modes are a bypass mode (no compression) and a noise measurement mode. The mode selection is externally controlled.

Application Fields

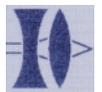
The ASIC developed can be used for any application where compression of gaussian data is required, such as radar signals, data gathered from surveillance operations (e.g. oil spills), etc.

Status

The ASIC developed is being used in SAR instruments in ESA's Envisat satellite, which will be launched in 2000, for compressing SAR data on board the spacecraft before transmission to the ground.

The ASIC is available for licence.

Ref. 394



ANALOGUE INTERMEDIATE FREQUENCY SWITCH MATRIX

Description

Analogue Intermediate Frequency (IF) range switch matrix and vector modulator with multiple (12-16) inputs and outputs. The units are manufactured as monolithic integrated circuits using commercial BiCMOS processes. The circuits are intended for telecommunications satellites with analogue repeater architecture. Other possible applications include analogue video-signal processing.

- 16 x 16 channel switch matrix and 12 x 12 channel vector modulator.
- Median frequency 160 MHz, bandwidth (satellite application) 30 MHz
- Insertion loss < 3 dB, isolation > 45 dB, crosstalk pin-to-pin < -40 dB, all hostile < -20 dB.

Vector Modulator additional features: 4-bit phase control 0-360°, 4-bit amplitude control.

Chip sizes: 8 x 8 mm², available in 84-pin leadless chip carriers

Innovative Aspects

The circuits are manufactured using a 0.8 μm junction isolated BiCMOS process. The largest commercially-available circuits currently manufactured using this technology have fewer input and output pins; the largest have 4x8 or 8x8. One manufacturer offers a 16x16 switch matrix manufactured using the more expensive SOI (Silicon On-Insulator) process technology.

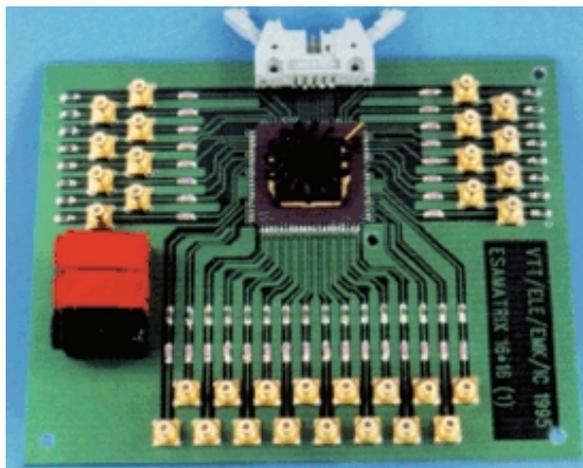
Application Fields

- IF signal routing
- beam forming
- video signal routing
- analogue signal processing.

Status

The circuits are appraisal prototypes. They are manufactured using a commercial BiCMOS process and are ready for mass production without any technology or design transfers. The prototypes are in 84-pin LCC packages. Easy modification, i.e. flip-chip assembly technology, is possible.

Ref. 395



RIGID-FLEX CIRCUIT BOARDS

Description

Only a few printed-circuit-board technologies meet the following high-grade standard demanded by space aviation:

- Materials of low expansibility
- Materials of high temperature stability
- High component density with few layers
- Use of buried holes and blind holes
- Combination of rigid and flexible zones
- Minimum surface expansibility
- Minimum weight.

The optimum realisation of the above-mentioned requirements can be found with rigid-flexible circuit boards. Using specialised technologies, it is possible to meet almost all the above requirements. The printed-circuit-board material used in space aviation can be applied to many high-technology problems in terrestrial applications.

The electronic printed circuit board (see illustration) has been developed for a space optical camera. The conductor board comprises 8 layers, the two inner layers of which have been pulled out in order to firmly connect rigid circuit components without solder joints. For the head portion of the camera, the flexible part is spherically dimensioned, with contacts having a foil thickness of only 150 µm.

The latest vacuum pressing techniques enable critical changes from rigid to flexible conditions to be easily achieved. This was particularly useful in cases where bending over edges had to be performed.

Innovative Aspects

The processes developed offer the possibility of customising electronic circuits for cramped operating conditions under extreme load. Innovative vacuum pressing techniques enable rigid and flexible circuit zones to form a rigid unit without soldering joints.

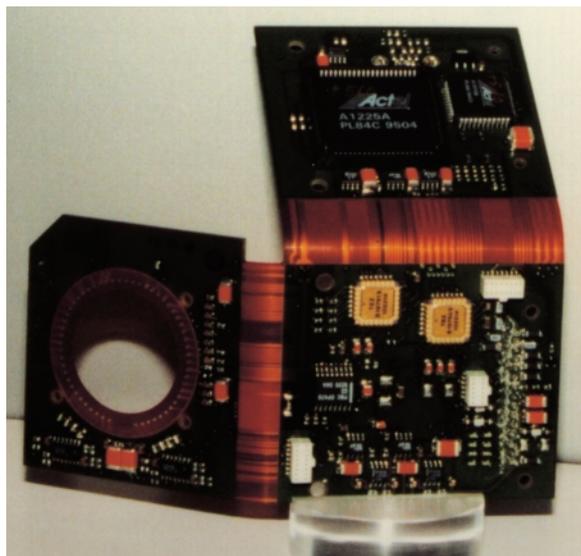
Application Fields

Rigid-flex circuit boards can be used in all cases where very high standards need to be met and where an extremely small and sturdy load-bearing construction is needed.

Status

Design, construction and manufacturing of high-tech printed circuits is offered to meet customer-specific applications. Bespoke manufacturing processes offering on-line assemblies and testing as well as construction designs can be provided.

Ref. 396



HIGH-THROUGHPUT REAL-TIME IMAGE DATA COMPRESSOR

Description

In the last few years, industrial image processing has embraced digital technology. Digital image processing reduces costs and improves the flexibility of image processing applications. The performance of digital imaging systems, specifically the resolution of sensor arrays and the recording-speed of scanners, is rapidly improving and so the need for efficient image compression solutions has emerged.

The technology introduced here is a very fast, digital processor for compression and correction of image data. The processor is developed for on-board use in satellites in conjunction with high-resolution optical instruments to reduce the amount of data generated before transmission to earth.

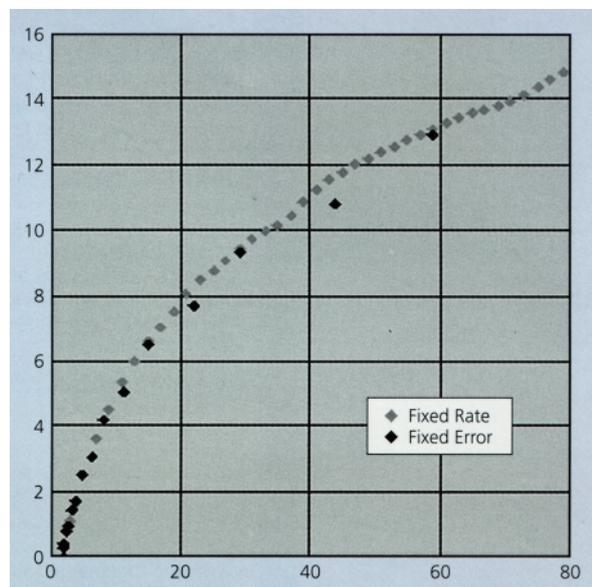
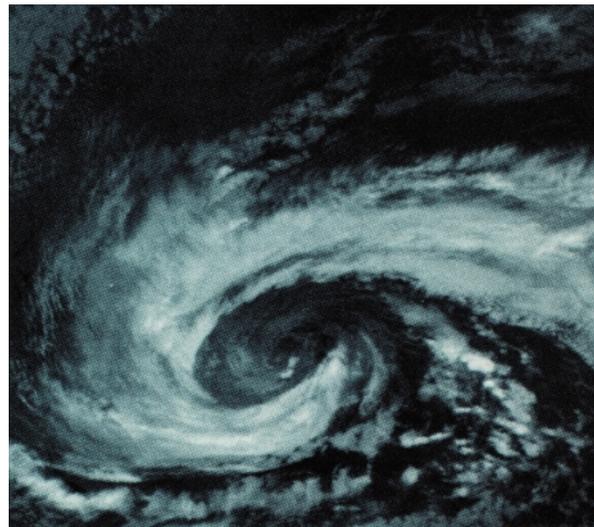
Pixel correction is performed in a first optional submodule. Subsequent data compression takes place in a data compressor submodule.

The need for pixel correction arises from the fact that the individual detectors in the CCD-array usually do not respond perfectly uniformly to a given illumination. Pixel correction is necessary so that the compression meets the highest quality requirements (e.g. lossless image compression and subsequent quantitative image utilization). The correction performed removes noise introduced by pixel non-uniformity and increases the compression efficiency.

The data compressor can work either in fixed-error mode (a predefined image quality is assumed) or in fixed rate mode (the compression ratio is defined). In fixed-error mode, the resulting compression ratio depends on the content of the image compressed. Different images have different compression behaviours. Some images can be compressed more easily than others. In fixed-rate mode, the quality of the compressed images depends on the image content if the same compression ratio is used.

The special case of lossless compression is available, as well as very high compression ratios (> 50). As a result of the use of a wavelet-filter, no blockiness is visible even at high compression ratios.

With respect to high data throughput, the processor is designed as a hardware solution and realized with application-specific integrated circuits (ASICs). With space-qualified devices, the area budget for the digital processor is equivalent to two boards in the Double Europe card format. An input data rate of 10 million samples a second with 16 bits a pixel can be processed. The scalable architecture allows a reduction in hardware costs if lower compression performance is needed.



Innovative Aspects

The digital processor uses state-of-the-art wavelet-based compression techniques, implemented for the first time in hardware, to meet the needs of high-performance image processing. Modern wavelet-based compression methods allow either the lossless compression of image data, outperforming other lossless compression schemes, and lossy compression with best control over the compression parameters. The amount of data generated by the digital processor can be controlled in fixed-rate mode. The output data stream exactly meets the bandwidth of the following transmission channel with optimal coding efficiency. In fixed-error mode, the quality of the compressed image can be controlled. Lossless compression is a special case of fixed-error compression where the compression error is set to zero. The architecture of the processor allows the consumption of image data generated by line-sensor elements continuously producing image data. The compressed image appears as an image stripe of any height without any of the blocking effects normally

introduced at higher compression ratios. Additional features include:

- Variable image format, any image height
- 16 bit pixel resolution
- Full-size image compression
- Two-dimensional wavelet filtering at all transformation stages
- Usage of modern coding techniques.

Application Fields

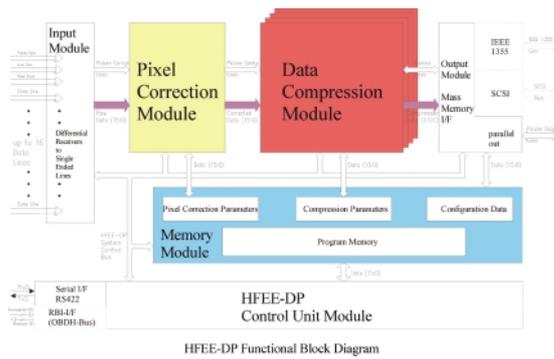
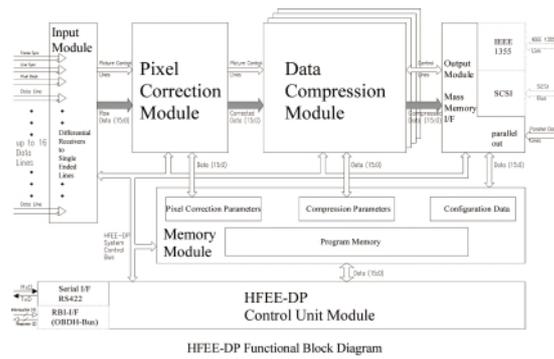
The architecture of the digital processor meets the needs of high-speed or real-time image processing systems. It is particularly suited to high-performance image archiving and image or video communication systems. Components of the digital processor can be combined with other modules, e.g. the combination of the wavelet transform with high-performance DSP-systems for de-noising of raw image material.

Status

The data compressor uses a compression technology which outperforms any other still-image compression techniques currently available in hardware. Essential features like lossless compression and 16 bit pixel depth are added to meet the needs of present and future image-processing applications. The flexible architecture of the digital processor allows adaptation of the compression either to higher or to lower compression performance to find the best compression solution needed in specific image processing systems.

Licensing and sales of the processor are of interest. Cooperation is welcome.

Ref. 397



AUTONOMOUS ENVIRONMENTAL PROTECTION OF THE HUMAN BODY (PACHA)

Description

Under extreme environmental conditions the human body will show signs of climatic stress which can be relieved by making the environment more comfortable. However, in certain hostile environments this conditioning is not possible (for example, as experienced during certain outdoor pursuits like motorbike riding or in extremely hostile industrial environments like exposure to industrial ovens, etc.). In these cases the solution could be the conditioning of a micro-climate around the subject's skin.

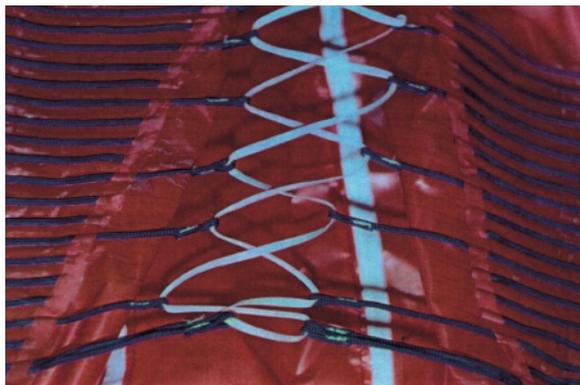
The technology presented here applies this principle to realise a portable individual conditioning suit. The approach makes use of an air distribution unit (that spreads conditioned air around the subject's skin) and a thermal conditioning unit. The air distribution unit has been formed out of a tight elastic fabric suit that covers the entire body or part of it (depending on the application). This unit can be an overall or a jacket. The air is conditioned in a unit that uses Peltier-based technology developed by the donor to cool the air, and uses technology already applied in space projects. The whole system has been tested with subjects under thermal stress. Trials have been carried out on the air conditioning unit in order to identify the perceived 'comfort' operating parameters.

The technology has proved to be useful in different thermal situations (temperature and relative humidity) and has entered a phase of specification definition in order to produce commercial prototypes. The existing prototypes cover several scenarios, from less restrictive environmental conditions with an air-conditioned system (hermetically sealed suit with a filter for air input) to more severe conditions for chemical and biological environments.

The system is modular with different possibilities to be adapted to specific conditions (i.e. to distribution applications: jacket or suit). The donor has also tested several subsystems to evaluate integral alarms designed for different applications.

Innovative Aspects

The innovative aspect is the establishment of a micro-climate created within a suit in order to maintain a comfortable environment for a subject. The design of the suit and the utilisation of the Peltier technology are also an innovative aspect of the technology.



Application Fields

Protection against internal and external harsh environments. For example:

- industrial furnace foundries
- petrochemical.

Status

Prototypes are available. Joint ventures, licence agreements, and co-operation are sought.

Ref. 398



TRANSCARDIAC-IMPEDANCE MEASUREMENT (TIM)

Description

Transcardiac-Impedance Measurement refers to a new technology to evaluate stroke volume and cardiac output, achieved by detecting the electrical impedance of a low alternating current passing through the patient's heart.

The measurement is performed by inserting two electrodes near the right atrium using a tracheal tube, an oesophageal or central venous catheter. Two additional electrodes are then attached to the skin on the opposite side of the heart. The heart is connected to an external skin electrode via an internal catheter electrode. Tissue impedance, which is mainly influenced by blood content, is measured using a second dermal and second internal electrode. Because impedance curves of the cardiac cycle are superimposed onto a background trace composed of signatures derived from other phenomena, but especially respiratory, a second impedance measurement at a second frequency is simultaneously performed to differentiate between the two signal sources. Both impedance curves are A/D converted before being fed through to a PC.

The measurement system affords a large signal-to-noise ratio. Transcardiac impedance curves show a volume curve of that part of the heart which is electrically connected to the internal and external driving and measuring electrodes. The second AC frequency measurement compensates for respiratory influences upon mechanical heart action. Stroke volume can be calculated for a defined period of respiration, which can be chosen arbitrarily.

The simultaneous measurement of a second impedance curve can also be used to observe volume curves of other regions, or the heart or blood circulation. All impedance curves and two additional ECG curves, which are simultaneously recorded from the impedance electrodes, can be displayed, compared and calculated by the PC. After electrode placement the systems allows the remote monitoring of the electrical and mechanical heart action and respiration. Electrodes are positioned for optimal ECG signature, as recorded by impedance measurement.

Blood and body fluids have a higher electrical conductivity than tissue. That means if fluid density is higher, electrical resistance decreases and electrical conductivity increases. Conductivity can be measured by AC currents of different frequencies. Resistance depending on frequency is called "Impedance".

By measuring the impedance of a human leg of an upright person one can see that impedance is lower than that from a prostrate person. This is because gravity causes more fluid to be contained in the lower part of the body. Simultaneous measurements on



different body parts show fluid distribution in the whole body. Variations in frequency allow the share of tissue and body fluids to be determined. What would be easier than to measure impedance in space in a weightless situation? During the D2 and MIR missions, experiments on the distribution of fluids in the body were carried out. A second possibility is the measurement of the impedance in the haemodynamics (circulatory system).

Changes in impedance are determined for every heart beat, the change in the impedance per unit time, the ejection time of the heart, heart frequency and, after the application of certain voluntary parameters, the stroke volume. All these parameters can be determined by the impedance measurement method because a widening of the aorta occurs as a result of the heart beat, causing a lower impedance through increased fluid. Back on Earth, all of these measurements can be performed on a patient. By comparing and contrasting with ideal measurements taken from a healthy astronaut in space (in a weightless environment), one can diagnose patient symptoms.

Innovative Aspects

The transcardiac measurement provides:

- a continuous and remote monitoring of cardiac output
- higher signal-to-noise ratio compared to dermal impedance procedures
- simultaneous measurement at two frequencies for the evaluation of specific impedance pathways of the thoracic cavity
- recordings of pressure/volume loops of the cardiac cycle if arterial pressure is simultaneously measured
- specific alarm functions for heart action and respiration.

Application Fields

Medical and sports/training applications.

Status

Co-operations sought.

Ref. 399

ORGANIC WASTE RECYCLING BY THERMOPHILIC AND PHOTOSYNTHETIC STRAINS

Description

The food production, pharmacology cosmetics and environmental control industries have exploited biotechnology know-how (for example, batch processes) widely since the 1940's. Difficulties in mastering continuous processing systems have hindered exploitation of their potential (cost) benefits. But now the deterministic engineering approach afforded by Melissa has delivered results which are of direct interest to industry.

Melissa (Micro-ecological Life Support System alternative) is a model for studying biological life support systems. The separate compartments of the Melissa loop and the choice of the micro-organisms simplify the loop's behaviour and allow a deterministic engineering approach.

Innovative Aspects

The main aspects and benefits are:

- No methane production
- Production of food for animals
- No consumables
- Complete recycling.

Application Fields

The technology could be used for waste and water treatment in agriculture and environmental technology.

Status

An engineering model is available. The technology is patented and licences are sought.

Ref. 400

