

Deliverable 3.5
Management Story Book
Video Decoder Platform (VDP) Project
EP29644 :VDP

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Video Decoder Platform

Abstract.

The VDP project started in 1998 under the auspices of the Fourth framework IST programme called Video decoder platform (EP29644- total funding 1.89Meuro). It started out as a speculative effort at evaluating the improvement in resolution that could be achieved for video applications by adopting similar approaches as those used for Audio . In particular the Sigma Delta architecture is one which has been able to generate very high resolution data converters without the trimming necessary in the more traditional converter architectures. The aim of this project was to evaluate the possibility of using the sigma delta architecture approach to build data converters for video applications. Clearly this was not a simple task since video has substantially shorter conversion time requirements and it is much more difficult to achieve high resolution specifications.

The VDP project was a collaboration between Analog Devices, the electronics product design centre of PEI technologies which is a campus company based in the University of Limerick and NMRC a semi autonomous research institute based in University College Cork . In this project the academic partners have contributed design and sigma delta architecture background to the project and Analog devices have implemented these suggested improvements in the circuit designs and product ranges. Various architectural modifications have been evaluated in the course of the project and at this stage one product is sampling at customers at present with three other products at various stages of completion.

Video Decoder Platform

Partners

Analog Devices Inc.

Raheen Industrial Estate
Limerick
Ireland

Power Electronics Ireland

Electronics Product Design Group
Department Of Electronic Engineering,
University Of Limerick,
Limerick,
Ireland.

NMRC,

Si Technology Applications Research Group
Prospect Row,
Cork,
Ireland.

Partner Descriptions.

Analog Devices

Analog Devices, Inc. is a world leader in the design, manufacture, and marketing of high-performance Analog, mixed-signal and digital signal processing (DSP) integrated circuits (ICs) used in signal processing applications. ADI's products are sold to a wide diversity of customers in the communications, computer, consumer, and industrial markets. During FY2001, approximately 40% of ADI's revenues were derived from the industrial market, 38% from the communications market and the remaining 22% from the computer and consumer markets. ADI's products are sold to over 60,000 customers world wide through a direct sales force, third-party industrial distributors and independent sales representatives. The Company has direct sales offices in 19 countries, including the United States. Approximately 39% of ADI's FY2001 revenues came from customers in North America, while most of the balance came from customers in Europe and Asia. The Company is headquartered near Boston, in Norwood, Massachusetts, and has manufacturing facilities in Massachusetts, California, North Carolina, Ireland, the Philippines, Taiwan and the United Kingdom. Founded in 1965, ADI employs approximately 8,800 people world wide. The Company's stock (NYSE: ADI) is included in the Standard & Poor's 500 Index.

PEI Limerick

The PEI Technologies Electronic Product Development Centre at the University of Limerick is part of a government sponsored Programme in Advanced Technology. The Limerick Centre, which is qualified to ISO9001 standards, conducts research and provides commercial design services in the following technology areas:-

Embedded Systems & Control Networks

CAN, Industrial Ethernet, USB and IEEE1451 Smart Sensor Networks

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Mixed Signal IC Design and Instrumentation EMC/High Frequency Design.

Each activity is supported by a corresponding research programme at the University of Limerick. The focal point of our research is real time control networks and we carry out research on topics ranging from mixed signal IC design for hardware realisation of network nodes, through embedded system design, operating systems to software engineering. The research activity of the University's Circuits and Systems Research Centre generates and supports the know-how that PEI uses in commercial projects. Ultimately we expect to be designing high performance network nodes on a single chip, as well as conducting the research which will define the network and it's protocol

The focal point of PEI's design/research activity is embedded system design as applied to real time control networks. To support this, research is carried out on topics ranging from mixed signal IC design for hardware realisation of network nodes, through embedded system design, operating systems research to RF design and software engineering. The research activity of the centre generates and supports the know-how that PEI use in commercial projects. The Centre presently has three core activities, each led by an academic:

- Fieldbus and Distributed Control
- Mixed Signal IC Design and Instrumentation
- EMC/High Frequency Design

NMRC

NMRC was established in 1981 with a staff of 20 people. The Centre has a dual mission; firstly to be a world-class centre of excellence in ICT and secondly to be a key part of the national science, technology and innovation infrastructure; supporting existing indigenous and multinational industry, providing highly skilled staff for Irish industry and stimulating new indigenous industry and inward investment from foreign companies.

NMRC, a fully ISO-9001 certified organisation, today is a centre of excellence in selected Information and Communication Technology fields. Our premier position in the Irish research infrastructure and the strength of NMRC in basic long-term research is reflected in the decision by the Irish Government's Higher Education Authority Programme for Research in Third Level Institutions (P RTLI) 1999-2001 to establish a National Nanofabrication Facility (NNF) at NMRC. Evidence of the significant expansion in the depth and breadth of basic ICT-related technological research being undertaken at NMRC is also reflected in the fact that NMRC has achieved 100% success in the first Science Foundation Ireland (SFI) Basic Research call for proposals. Since its foundation, NMRC has acted as a high-tech skills incubator with a number of initiatives both to address specific existing skills shortages in selected areas of the ICT sector and to ensure the availability of skilled personnel in future emerging ICT fields. These programmes include full-time and part-time undergraduate and postgraduate courses, industry-wide technical support groups, industry skills groups and, looking towards future generations, participation in activities to promote science and technology in the second-level educational system.

NMRC is the premier training and education facility in ICT-related technologies in Ireland. Currently, the Centre hosts a total of 98 full-time and part-time (industry-spon
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sored) postgraduates, which is the largest body of ICT-related postgraduates in the country. A recent survey of past graduates has shown that over 355 have graduated from NMRC, of which over 50% are currently working in Ireland, with an increasing number of foreign-based NMRC graduates now returning to take up employment with Irish indigenous and multinational companies.

Participation of NMRC in National and European research programmes over the last 18 years has provided an important conduit for ICT excellence to Irish industry. NMRC has leveraged these collaborations to build its research expertise and technology portfolio which now provides the basis for it to support the long-term development of the ICT sector in Ireland and Europe. NMRC now provides industry and higher education establishments with access to an extensive range of technology and infrastructure from advanced research to new product development. The Centre currently has a total floor area of 6,000 sq metres of laboratory and support space and has received funding to expand this by an additional 1,500 square metres. The availability of this critical infrastructure of ICT knowledge, expertise and facilities will be an increasingly important strategic factor in both stimulating the creation of new indigenous industry and in attracting inward investment to Ireland in this knowledge-based economic era.

Reflecting NMRC's role as the hub of Ireland's ICT infrastructure, the Centre interacts with all Irish third level Universities. This is supported in part by a joint initiative between the Office of Science and Technology and Enterprise Ireland, who sponsor an NMRC Facility Usage Scheme (FUS). To-date, the programme has sponsored over 20 projects from Irish Universities and Institutes of including TCD, UCD, UCG, UL, DCU and CIT. It is anticipated that the programme will be expanded in the coming year to facilitate access to the National Nanofabrication Facility at NMRC. Entering this new decade, NMRC is the ICT research centre in Ireland, a key European ICT research hub and an international player in ICT innovation. It has a critical mass of over 200 staff and a significant research infrastructure currently valued at over E101 million.

The Video Decoder Platform Project

Introduction

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The VDP project is a collaboration between Analog Devices, the electronics product design centre of PEI technologies which is a campus company based in the University of Limerick and NMRC a semi autonomous research institute based in University College Cork . In this project the academic partners have contributed design and sigma delta architecture background to the project and Analog devices have implemented these suggested improvements in the circuit designs and product ranges. Various architectural modifications have been evaluated in the course of the project and at this stage one product is sampling at customers at present with three other products at various stages of completion.

The three organizations have benefited greatly from the development. Analog Devices has now announced to its customer base and received very positive endorsement of the NSV technology product family. The first customer has committed to placing the NSV logo on the front of the highest end DVD for release in Autumn 2001. NSV brand will be on Analog Devices integrated circuits from early prototypes in June 2001. Numerous patents have been filed to protect the intellectual property and a product roadmap on the family of products has been created as part of the next business planning cycle at Analog Devices. The company is encouraged by the response from the marketplace and the exceptional level of pre-production orders. At this stage it is accepted that the product family has its own commercial case justified to the level required by Analog Devices to fund the derivative product family that has been identified. The Fourth framework funding was essential in allowing the seeds for this technology to be generated.

The research organizations of PEI and NMRC are also greatly encouraged by the exposure they have gotten to state of the art design practices and by the amount of course intellectual property they have developed out of the co-operation in EP29644 and within the Mixed-signal design cluster. The work has fostered links within the Mixed-signal Design Cluster across EU and with other research institutions. Participation in cluster meetings has improved the partners mixed-signal design expertise particularly in the area of substrate coupling. These courses are now being exploited by the partners as part of their internal courses and also being offered to external course participants.

The following website is instructive in demonstrating the degree of shared learning within the development.

<http://www.imse.cnm.es/esd-msd/deliverables.html>

The Noise Shaped Video Concept

Background

In Delta-Sigma Modulation, high resolution is obtained by combining oversampling together with noise-shaping in order to modulate the quantization noise outside the baseband, so that most of the noise can be eliminated by low pass filtering. 1bit D/A Converters utilizing high order modulators and very high oversampling ratios are well established in audio signal processing and these converters can readily achieve better than 16bits of resolution. However, video applications require bandwidths that are much higher than those required for audio. For example NTSC video broadcast standard requires a baseband of 6.75MHz and new higher definition standards such as Progressive Scan television and High Definition Television require bandwidths of 13.5MHz and 40.5 MHz respectively. To date the high oversampling ratios required by single bit delta sigma modulators has prevented their adoption in video processing.

The Noise Shaped Video (NSV) Concept

Multi-bit Delta-Sigma modulators are known to be able to achieve similar resolution to single bit modulators while using much reduced over-sampling ratios. However, the major limitation of the multi-bit sigma delta architecture, is the requirement placed on the matching of the D/A converter. In this instance the converter must have an intrinsic matching equal to the number of bits at the input of the delta-sigma modulator.

How NSV Works

Noise shaping techniques can be combined with dynamic element matching techniques in order to reduce the matching requirements of DAC elements by converting the analog mismatch into out of band noise. This approach of dynamic element matching and noise shaping has been shown to allow the use of sigma delta modulation at video data rates. This is the basis of the family of data converters that are the subject of this application

Application Areas

The NSV family of products are used in

- a] the conversion of analogue signals to digital data representations with superb fidelity (better than 12bits) and
- b] The conversion of Digital data representations to analogue signals with (better than 12bit resolution)

Both sides of product range are used in the HDTV and DVD markets to convert a video signal into one that can be understood by a microprocessor and DSP and then after manipulation reinterpret the data in a very precise fashion. NSV is the only product on the market that can achieve this with 12-bit fidelity in both Digital to Analogue and Analogue to Digital domains.

Market Analysis

The main users of this product family are manufacturers of HDTV and DVD entertainment systems. At present the target market is for high end DVD and HD-TV. However, once the technology is demonstrated and accepted by the target market it is anticipated that a more ubiquitous penetration across the full range (from low end to specialist) of video products can be achieved. Typical users who have so far expressed an interest in this technology are Sony, Matsushita, Toshiba and Thomson Multimedia. In addition to the adoption of the NSV technology, these manufacturers anticipate advertising the fact that they use *Analog Devices NSV* in their products to achieve market distinction and product positioning at the high end of the video equipment spectrum due to the high resolution that can be achieved by using NSV and of key importance is the greater market recognition and differentiation customers get from employing NSV brand on their end products.

The IT content in this product is clear. The transition from Analogue Video to Digital has created a growing market for A/D and D/A video conversion products and it has become necessary to bridge conversion functions (i.e. new digital transmissions or DVD players must hook up to conventional analogue televisions and analogue and digital signals must coexist on the same medium (e.g. DTV[COFDM or VSB] & DVB-QAM) with Analog based NTSC/PAL (Multi-Standard Video-Pipe). Our intention in establishing this product range has been on identifying and exploiting those segments of the market which require "Superior Mixed Signal Conversion/Acquisition" and "Advanced Signal Processing". These products have been demonstrated to provide very accurate data conversion at video frame rates for HDTV and DVD applications which was not previously possible using traditional architectures.

Collaboration Between The Partners

The innovation that has been demonstrated in this product family has been to take an architecture that has been used for some time to make high precision Sigma Delta audio data converters and apply the concepts along with some architectural enhancements (such as bit shuffling) to enable the manufacture of very high speed, high precision video products for the rapidly growing DVD and HDTV markets. These innovations were first demonstrated and published through collaboration with the research labs who were working on advanced system architectures and novel circuit topology concepts within the project.

Benefit To Analog Devices

Analog Devices is a semiconductor company that develops, manufactures and markets high-performance integrated circuits (ICs) used in signal-processing applications. The Company's largest single product group is general-purpose Standard Linear ICs (SLICs), which include data converters and amplifiers. ADI has also become a major Digital Signal Processing (DSP) IC supplier, providing both general-purpose DSPs and highly integrated application-specific devices that combine analog and digital signal-processing capability in a single IC. Clearly the NSV product family is fully in line with the Analog Devices product line and marketing strategy and it addresses the requirements for high quality data converter products in a new and burgeoning market.

The products developed within this project represent the first generation of a new technology developed specifically to address the requirements of advanced HDTV and DVD companies. The video product line within Analog Devices already has six years of success in the DVD market. This latest NSV technology has been validated by customers as an important value proposition and will be the banner under which the next generation of mixed signal video products will be marketed by Analog Devices.

This product family presents a significant value proposition to OEM customers and ultimately consumers in the area of HDTV and DVD electronics. It is a product of such significance that Japanese and European consumer electronics manufacturers require to distinguish the high quality of their branded products by co advertising the utilisation of the NSV product along with their own brand name. This approach makes the possibility of distinguishing the quality of a product by the presence of the NSV logo in the same way as, for example, Dolby did for noise reduction in audio applications. This is a European brand that has been generated on the basis of IP developed in the course of this IST project (EP 29644 - Video Decoder Platform). The prestige that accrues from the winning of an IT award is demonstrating to the world that the IST programme is developing substantial intellectual property in Europe which has wide ranging and internationally recognised industrial merit.

General Benefits From Participation in VDP

Participation in this project has led to the filing of three patents and several papers in international conference proceedings. In this process of the work in the project, the two labs involved have learnt how to work closely with the industrial company to mutual benefit. The benefits to the laboratories were that they received market intelligence on the general trends in the market place and the definition of specific industrial problems that required to be solved. The industrial partner was able to explore novel circuit concepts without having to explicitly assign engineering time to them. This allowed the company to research new markets for existing technological background and it has resulted in the development of a new product family for Analog Devices which has enormous world wide potential in the HDTV market place.

This project clearly provided a source of funding for graduate students and staff in the labs, and facilitated the design of new speculative product concepts in the area of mixed signal circuit design. In total twelve post graduate students (see Appendix1) were supported in the course of their degrees in both financial and intellectual ways. Information on specific topics were jointly identified which were of interest to the labs for the intellectual challenge and to the industrial partner because it provided solutions to some of the problems that they were experiencing in their new product development activities.

Conclusions

All partners benefited from this project and a substantial amount of good will and methods for working in multi disciplinary research programmes were identified. Analog Devices clearly benefited from this project through the development of the NSV professional quality data converters that they ultimately developed. The experience that they gained was positive. However, on reflection it became clear that the project leadership was a much more substantial burden that could easily be supported within a large commercial organisation. This experience has led the management of Analog

Devices to conclude that although they are very happy with the outcome of the VDP project, any subsequent projects would be lead by an academic partner who tend to be more used to the demands associated with participation in the IST programmes.

Appendix I Table of Degrees Involving Participants in VDP

Name	Degree	Completion Date	University	Project
Guido Retz	MEng	Dec 2000	Limerick	A Reference Buffer for a 13.5 MS/s 72dB SNR Sigma Delta A/D Converter in 0.25 μ m CMOS Architectural Analysis and Implementation of Integrated Receiver Architectures for Cable-Bound and Terrestrial Broadcast Applications
	PhD	Aug 2002	Limerick	
Gerry Quilligan	MEng	Dec 1999	Limerick	Wideband Common Mode Feedback and the Replica Bias Method
	PhD	Aug 2002	Limerick	
Tony Scanlan	MEng	Aug 2001	Limerick	Theory Design and Implementation of a 10 bit, 6.25MHz Digital to Analog Converter for Mixed Signal Video Circuits.
Ivan Ryan	MEng	Aug 2001	Limerick	Using noise shaping to allow arbitrary rate conversion in high speed oversampled systems.
Tudor Vinereanu	M.Eng.Sc	July 1999	Cork	Low Power, High Speed CMOS VLSI Architecture
John Healy	M.Eng.Sc	July 2000	Cork	Second Order Multibit Sigma Delta Modulator
John Ivan O'Connell	PhD	June 2001	Cork	Very High Accuracy, Low Power, Sigma Delta ADC's
Tom Tansley	M.Eng.Sc	June 2000	Cork	A Power Efficient Audio Quality Amplifier
Aedan Keady	PhD	May 2000	Cork	Sigma Delta Converter Architectures
Darren Collins:	M.Eng.Sc	May 2000	Cork	Applications of Planar Magnetics on Voltage Isolated Digital Links
John Collins	M.Eng.Sc	June 2001	Cork	Parallel Sigma - Delta Modulator