IMPROVED PROCESSING PERFORMANCE ENLIVENS NEW TYPES OF ADVANCED MEASUREMENT SYSTEMS

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Using more advanced system design tools for embedded processors is just the start of a new era of system development for any measurement devices. With powerful processors like Blackfin and SHARC, designers can overcome development boundaries and realise highly functional devices rapidly and even to full series of production. This article describes some examples of "idea to final product" with these powerful new design methodologies.

Over the past decades, measurement designs have been based on in-house technology along with specific design IP linked with focus within markets. With the technology jump into this century, processor performance has improved and a new era of deployment technology has started the seed into more advanced designs. Based on the demand from consumers and manufacturing, it is nowadays critical for designers to be able to reuse existing designs for a more scaled design methodology in new innovations.

NARI BENEFITS FROM SHARC AND BLACKFIN PROCESSORS

One manufacturer, Nanjing Nari-Relays Electric Co., Ltd. (Nari) is regarded as a world leader in the areas of research and manufacturing of numerical protection, automation and control systems for both high voltage AC and DC power systems. Nari's technical leadership is evident in their complete product lines, built around their unique and patented technologies. Nari is an engineering-driven company committed to serving electric power utilities and industrial customers worldwide. The Chinese electrical power system has achieved high levels of stability in part, due to the widespread use of Nari numerical relay products with their extremely high reliability. The incidence of power failures in the Chinese power grid due to a fault or other operating condition has been significantly reduced.

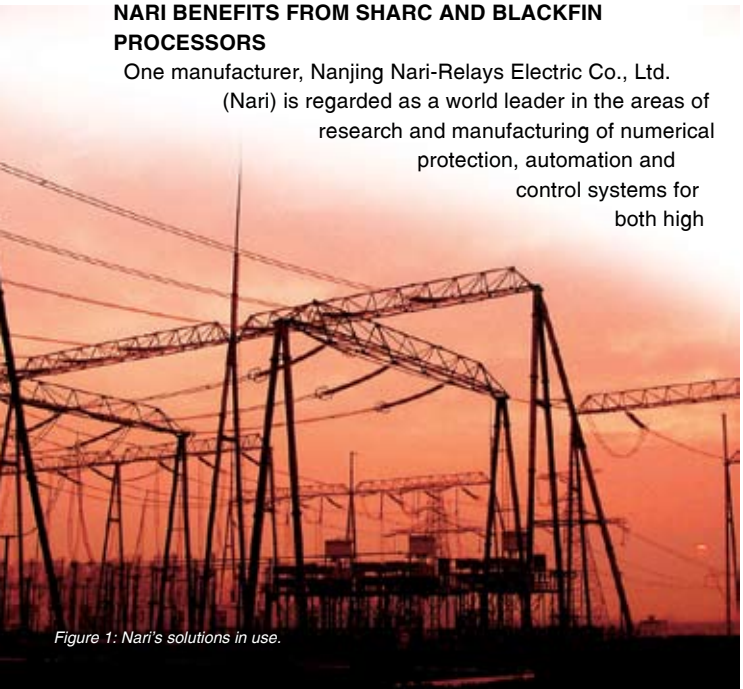

Figure 1: Nari's solutions in use.

Ten years ago, Nari started to use the 218x family of 16 bit fixed point DSPs from Analog Devices. Up to that time, most of their embedded processing had been based on general purpose microprocessor architectures. When the Blackfin family became available, Nari started using Blackfin in protection devices. Their use of signal processing architectures expanded as multiple successful products based on Blackfin and SHARC replaced microprocessors and microcontroller-based designs. Most of their new designs are based on Analog Devices processors.

Nari found that the performance of the Blackfin and SHARC solutions was superior in the critical applications of sensing and reacting to faults and transient events in the power grid. These functions are very critical to the reliability of the nationwide power grid, from the large generation stations to the residential transformer, and at every point in between.

Performance is a key attribute that contributes to the success of ADI's processors in these industrial applications. The ability to connect to input and output devices such as converters and switches is also important. Being able to rapidly measure and analyze system conditions is an obvious requirement. A less obvious attribute that is important for these designs is 'power', or more precisely 'low power', for operation in space constrained housings without cooling. ADI's Blackfin and SHARC processors are used in a wide range of applications with diverse end-user requirements, all relying on the processors' well-defined combination of performance, power, and peripherals.

The Blackfin processor inherently provides both microcontroller (MCU) and signal-processing functionality in a unified architecture, eliminating the need for separate digital signal and control processors. The processor's price/performance was another major attraction for Nari as Blackfin offers unprecedented processing power for its cost.

The Blackfin processor family was specifically designed to meet the computational demands and power constraints of industrial/instrumentation and communications applications like Nari's. Blackfin processors combine breakthrough signal-processing performance and power efficiency with a RISC programming model, allowing flexible resource allocation between hard real-time signal-processing tasks and system control tasks on the same processor. The programmable nature of the Blackfin processor made it easy for Nari to adapt its Blackfin-based hardware platform to create a whole family of products at price points that meet a wide variety of customers' requirements.

Complementing the Blackfin, ADI's SHARC DSP provides the performance capability for high end metering and protection systems. The SHARC family consists of a complete portfolio of three generations of products providing code-compatible solutions. The devices range from entry-level products priced at less than $10 to the highest performance products offering fixed- and floating-point computational power of up to 400 MHz/2400 MFLOPs. Irrespective of the specific product choice, all SHARC processors provide a common set of features and functionality useable across the full set of metering and measurement applications. This baseline functionality enables the SHARC user to leverage legacy code and design experience while transitioning to higher-performance, more highly integrated SHARC products.

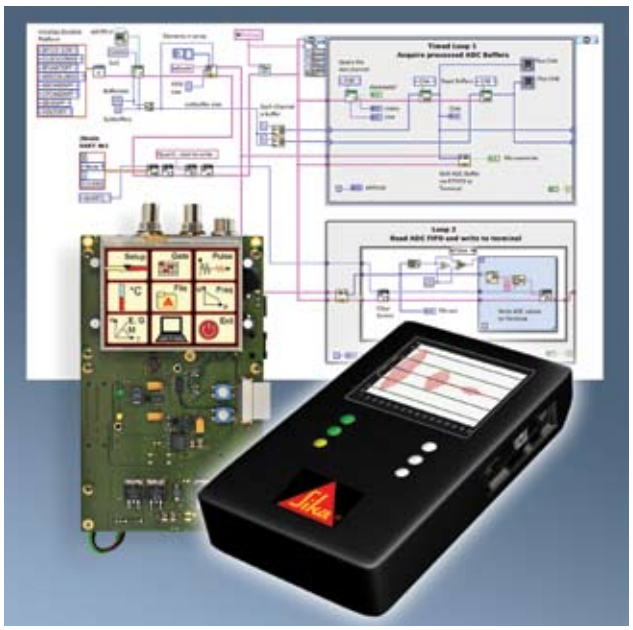

Figure 2: The ZMobile® Development offers final product an easy introduction to programming with LabVIEW Embedded

PORTABLE ULTRASOUND MEASUREMENTS

Another new measurement area is portable ultrasonic measurements, which have similar performance and quality needs as a relay system for security of power, though adding compact size, long battery life and ergonomic operation to the requirements.

Sika Technology AG in Switzerland is a globally integrated company supplying specialty chemicals markets. Sika Technology was looking for a supplier and consultancy to design a new family of ultrasonic portable measurement units. The design had to be scalable and have enough performance to provide Sika Technology with the flexibility for future product development. Additionally the design platform should reduce time to market for the entire family of products. To meet these needs, Sika Technology turned to Schmid Engineering's, ZMobile platform using the Blackfin® ADSP-BF548 processor family.

The new concept of ultrasound measurement can be compared to the echolocation of bats: an oscillation packet is emitted and the elapsed time until the echo returns is measured. Unlike acoustic methods, the frequencies lie in the MHz range. An algorithm developed by Sika Technology derives the exact response time and the amplitude from the echo signal, from which conclusions can be drawn about the material that is tested. The device comprises a multiplexer which executes ultrasound measurements on several different channels. At every measurement, important additional parameters such as the temperature are saved.

Mobile battery-powered testers must be small and consume little power to ensure a long operating time. Very often this is why, for technical reasons, an embedded PC cannot be used. Sika Technology evaluated which processors and platforms to use for an optimal end design, with a methodology to ensure minimum time spend for redesign. The ZMobile platform using an ADSP-BF548 could cover all of the required needs with one platform, and ensure scalability needed for a successful solution.

As well as scalability, the ZMobile platform had one major advantage for Sika Technologies: its framework build around LabVIEW Embedded. LabVIEW is the classic tool for solving numerous tasks concerning measurement, testing and automation technology. Usually computer controlled hardware is employed. For mobile devices however, which are limited by their weight, size, and energy consumption, the developer is usually forced to delve into the depths of low-level programming and to use a text-based programming language (Figure 2).

The possibility of programming the processor directly with LabVIEW is a real innovation. This approach is revolutionary because for the first time ever it enables the comprehensive graphical programming of an embedded system. Thus, the LabVIEW user is given the option to develop mobile applications in his familiar environment. The high degree of abstraction that the graphical programming obtains lends itself to simple systems as well as highly complex systems. A Fourier Transform calculation suddenly becomes as easy as accessing a digital port.

The programmer can use the familiar LabVIEW environment complete with palettes, block diagram and front panel. However, the front panel is used for debugging. For example, during runtime parameters can be changed and read. Most LabVIEW VIs, including the mathematics and signal processing blocks, are available without any restrictions. The board-specific functions that the respective hardware offers can be dragged and dropped from the VI palette into the application. Additional features provide target specific tasks such as creating and executing real-time code or loading a standalone application into the flash memory of the target system. However, an embedded system retains limited storage and processor resources which can lead to bottlenecks in the system's performance. Benchmarks, duly set, can prevent nasty surprises.

Apart from the advantages of graphical programming, LabVIEW offers with the embedded module a consistent programming language which can be used for feasibility studies, prototyping and serial production alike. The customized end platform suitable for serial production can be programmed in LabVIEW just like the prototype. The developed algorithms are reused 1:1 as VIs.

Exactly this procedure was employed for the ultrasound measurement device. Due to computer measurement technology and long LabVIEW experience, Sika Technology was able to acquire test data and develop the evaluation algorithm long before the start of the project. Only after this preliminary work was the final decision about the system taken, and Schmid Engineering employed as external development partner and solution provider. The evaluation algorithm and the specific know-how of Sika Technology were integrated step by step into the serial device.

CONCLUSIONS

This article has discussed two very different examples of how deployment with powerful processors like Blackfin or SHARC has enabled time to market reductions, ease of reuse, portability and minimal power usage.

It has been shown that Blackfin and SHARC processors enable designers to optimize designs for a wide range of markets, either with a cost/performance optimized solution or a more scalable platform solution. These methodologies are just the start of a new design trend. Over the coming years any silicon-, software- or system-design house will be forced to embrace new technologies in this area to enable higher quality and design cycles. MI

ABOUT THE AUTHOR: Anders Norlin Frederiksen holds a BScEE (Hons) from the Technical University of Denmark in 1994 – was Associate Professor at the Technical University of Denmark from 1995-1997). He joined Analog Devices in 1998 as system engineer on power electronics and control in Norwood (MA) and has subsequently had various roles within the organisation of Analog Devices. He currently holds a Global Industrial Marketing Manager role.