

NEC Electronics Responds to Evolving Applications

This special issue will introduce applications and various semiconductor technologies in the three main business sectors of NEC Electronics: SoC (System on Chip), microcomputers, and discrete & IC. In particular, this issue will focus on products that hold tremendous promise and the cutting-edge technologies such as basic LSI technologies and manufacturing technologies that make them possible while providing a look at how NEC Electronics is tackling the future.

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1 Introduction

Over the past several decades, semiconductors have achieved huge gains in performance as a result of CMOS scaling. Especially system LSI have seen advances in circuit design and architecture as well as software improvements, making possible large increases in areas like processing performance and low power consumption, greater sophistication of various application service quality, and increasing exploitation of expanding service opportunities. The heightened sophistication of service quality and its impact is exemplified by the widespread migration to high-quality digital video and images such as the shift to Hi-Vision in digital TVs and megapixel digital cameras. As an example of expanded exploitation of service opportunities, we can point to increasing connectivity of devices as a result of advances like the achievement of access to diverse networks through multimode wireless and the interlinking of everyday devices through PAN (Personal Area Network). Also in response to demands for enhanced safety and improved energy consumption as a consequence of growing concern about the environment, devices are becoming more intelligent. NEC Electronics has been providing the very latest semiconductor solutions in a variety of fields to meet the requirements of these increases in service quality and the evolving and expanding

needs of applications.

However, CMOS architecture continues to move toward ever finer design rules. When transistors are expressed on the nanometer scale, the order of complexity vastly increases and problems from a physical phenomenon perspective that have rarely been faced in the past arise. As a result of the explosive increase in the density of transistor integration, numerous issues such as the increasing design complexity have come to the forefront. Especially, there is a problem of a pronounced increase in LSI power consumption in step with the technology scaling due to the increase in leakage current and the slow down of voltage scaling while the number of transistors on a chip increases. Also, there are increasingly serious issues of deterioration in reliability and decreasing yield rates which are caused by the decline of process precision as well as the external factors such as cosmic ray induced soft error, as we move to finer design rules. In addition, the introduction of new material processes to improve transistor performance and increasing difficulty in design and testing have created the problems of ballooning development costs and longer development cycles. Seeking answers to these issues, NEC Electronics is moving forward with optimization of every layer of our technology from materials, processes, devices to applications and software, and strengthening the collaboration between our development and manufacturing to realize lower LSI power consumption and

higher reliability at lower development and manufacturing cost and with a reduction in development time.

2 Tackling the Evolution of Applications

This special issue will also introduce how NEC Electronics is responding to the evolution of applications. First of all, we will look at solutions for the recording of high definition, high quality video and images, beginning with an LSI that integrates “single-frame super-resolution” image processing to enhance the sense of resolution and sharpness of images that suffer from blurring and other degradation when legacy recorded images are enlarged and played back on the new generation of large-screen, high resolution display panels.

Next we will explain about the system LSI “EMMA3PF” - the world’s first single chip to integrate all the main functions of a BD player through the integration of a high-performance multicore CPU and graphic engine, and describe solutions comprising the reference board that incorporates the chip and the related software. Also this issue will provide a glimpse at engine solutions for mobile phone cameras including the “CE131” image processing camera engine that raises image resolution up to 8 megapixels, technologies to put a sensor and a lens together, module design technologies as well as image tuning and consulting services.

Regarding our solutions for the mobile and wireless domain, we will report on our development of 2G/3G dual-system telecommunications software built into the Medity2 (N905i series and later models), which responds to the shift to multi-mode service and realizes seamless handover between international roaming systems. In addition, we would like to introduce our latest switch IC technology and products developed for compact internal antennas for GSM+UMTS multiband/multi-mode mobile phone handsets as well as for FeliCa antenna impedance modulation.

Readers will also learn about our solutions aimed at energy-saving and lower power consumption for a variety of devices. One is the ultralow power-consumption 16-bit all-flash micro-computer 78K0R/Kx3-L lineup embedded with peripheral functions necessary for sensor functionality. The industry’s first $177\mu\text{A}@3\text{V}$ operating at 1MHz is achieved for mobile, sensor and battery driving applications. The other is the compact SDIP package ultrahigh speed coupler series that halves the footprint of previous 8-pin DIP (Dual Inline Package) and is ideal for FA devices that demand higher performance and a more compact system and for various types of inverter control for “white goods” home appliances.

3 Achieving Lower Power, Higher Reliability and Lower Cost

The latter half of this special issue will reveal how NEC Electronics is tackling ways to achieve lower power consumption, higher reliability and lower cost of LSIs, and our development of the next-generation of CMOS technology and advances in mass production technologies in each product area. Regarding our approach to advancing CMOS technology, we will introduce our ceaseless research and development in materials, processes and device architecture, all of which are essential to the creation of generation after generation of higher performance, higher reliability and lower power consumption devices. Next, we will present LSI design techniques, which enable exploitation of the maximum performance of transistors while maximizing LSI production yield rates by considering variations and layout-dependent fluctuations of transistor characteristics. In our report on the development of UX8 - 40nm node CMOS platform technology, we will introduce our achievement of gate density that doubles the previous generation by using latest in exposure technology, and the realization of a top global-class device platform that answers a wide spectrum of user needs from logic devices to embedded DRAM products.

Finally, we will describe the technologies that enable the mass production of high quality semiconductor products at low cost. In this part, we will introduce technology that paves the way for finer design rules for sub-55nm logic, specifically, our development of immersion lithography which elevates both exposure margin and resolution. This technology is applied to the production of 300mm wafer production at NEC Semiconductors Yamagata. We will also report on analysis technology that improves yield by using fault diagnostics to efficiently and quickly identify factors that cause decreases in logic LSI yield.

4 Conclusion

Through this special issue, we hope to have given the reader a broad understanding of how NEC Electronics is meeting the challenge of ever evolving semiconductor applications and responding to key demands such as reduced power consumption, improved reliability and lower cost. In the future, we shall continue to strive to provide our customers with technology and products that are at the cutting edge.