PROJECT RESULT

Enabling
IC technologies
for applications

MEDEA+

T123: CRESCENDO

Embedded-memory advances underpin more powerful user applications

The need to enhance the potential of non-volatile memory applications has risen in line with growing demand for system-on-chip (SoC) devices integral to modern industrial and consumer electronics manufacturing. Yet rising global competition is making it ever harder for Europe to maintain its lead in this key market sector. The MEDEA+ CRESCENDO project has helped to develop the capabilities of European semiconductor suppliers in this critical area, and to provide the foundation for new and more powerful embedded memory devices able to underpin a range of industrial and consumer applications.

The world market for embedded non-volatile memory (NVM) has grown fast in recent years, and has the potential to expand even more rapidly with future technology advances. Embedded NVM is an essential component in a wide range of advanced telecommunications and electronic micro-controller applications such as smart cards, mobile phone handsets, automotive electronics and other consumer products.

The smart-card market segment alone, which consists mainly of embedded NVM applications, is expected to triple in size within only a few years. European semiconductor producers benefit at present from a leadership position in this market; they supply some 80% of the market worldwide, with the European market itself forming around 50% of the total customer base.

Yet this leadership position is under increasing threat from fast advancing technology development being run elsewhere, especially in the Far East. Improved NVM technologies are vital if Europe is to maintain its leading position, and even capture market sectors where embedded NVM is a key enabler because of its cost, power, size and performance advantages.

Easier adaptation

The goal of the MEDEA+ T123 CRESCENDO project was to find ways to integrate non-volatile memory into pure logic, and to develop programmable designs that would improve the ability of semiconductor manufacturers to adapt their products to market needs. The project team also made progress in 0.18 and 0.13 μm flash memory technology and electrically erasable programmable read-only memory (EEPROM) cell architectures, and was able to reduce the writing voltages involved in the application of such cells. By the end of the project, the partners had achieved significant results. First was the successful development of a simple, cost-effective single poly flash memory cell that requires no additional process steps on top of the baseline CMOS process. Simplifying the production process for such cells reduces production costs and increases their attractiveness for use in trimming, security or system configuration applications.

A second innovation was the development of new uniform-channel Fowler-Nordheim 'erased and programmed' NVM cells that rely on quantum mechanical effects. Such cells facilitate the production of high-density flash and area-efficient, full-feature EEPROM memory. Both these memory options use the same process and can now be combined on the same chip.

Fowler-Nordheim tunnelling not only allows very low power consumption, which makes such cells ideal for wireless smart-card operation, but also reduces flash memory module sizes for medium-sized memory densities. EEPROM modules can therefore benefit from a reduction in size to around one fifth that of classical EEPROM memory. In addition, having embedded memory which is 100% compatible with baseline CMOS production makes it much easier to combine such modules with embedded SRAM and ROM memory, standard CMOS logic, hard core logic and analogue elements.

On the analogue side of the project, careful device modelling enabled the team to make real progress in developing high-performance analogue circuits. Improved insight into the effect of CMOS scaling on analogue performance also helped to integrate analogue functions in standard CMOS logic processes with high-performance logic and NVM memory.

Entering development

The NVM memory options developed in this MEDEA+ project are already finding their way into a number of consumer products, ranging from consumer electronics to automotive controllers and smart-card applications. The technology developed is being applied in next-generation devices with greater capacity, more processing power and improved flexibility. In the automotive sector, for example, this involves applications such as control of fuel burning or exhaust emissions, monitoring of engine performance and on-board service applications.

In the smart-card market sector, these same advances mean more features and facilities can be added to products such as bank cards, subscriber identity module (SIM) cards for mobile phones, radio frequency (RF) tags and security badges. The higher level of available computing power now allows the use of more complex passwords and higher levels of encryption.

Overall, the research in these NVM technologies has developed to the point that they are directly usable in partners' products. The project has proved they are both viable and reliable means that can be used in new products with a major part of the development challenge overcome.

More memory features and capacity also mean that manufacturers of electronic products can leave product customisation until much later in the manufacturing process. For example, in digital TVs it is possible to customise the feature set at the last minute according to the market or the product line being offered. In this way it is possible to produce a different 'touch and feel' for products while using the same basic chip components.

Ever higher integration

Looking ahead, the progress achieved by the CRESCENDO partners at the 90 nm level has helped tremendously in choosing the best type of memory cells – not just for new product developments, but also in defining the most promising direction for future research. For example, the results of CRESCENDO at the 90 nm level have formed the basis for the R&D tasks proposed in the MEDEA+ 2T201 NEMeSyS project. This initiative intends to develop non-volatile memory in the 65 nm technology level, which is the next headline challenge facing the semiconductor industry.

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Philips
STMicroelectronics

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Start: 1 January 2001
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