PROJECT PROFILE

# T122: Fitness of advanced semiconductor processes for 42 V battery supply in automotive applications (SC42V AUTOMOTIVE)

**ENABLING IC TECHNOLOGIES FOR APPLICATIONS**

**Partners:**

AMI Semiconductor
Robert Bosch
STMicroelectronics

**Project leader:**

Stefan Rübenacke,
Robert Bosch

**Key project dates:**

Start: July 2001
End: December 2004

**Countries involved:**

Belgium
Germany
Italy

**This decade will mark a new trend in vehicle electronics: current 14 V battery systems are no longer adequate alone to provide the power required. Higher voltages are essential to supply an increasing number of components for safety, comfort and exhaust emission control and help them run reliably. This MEDEA+ project is determining which state-of-the-art semiconductor processes can support advanced system designs for new generation 42 V battery systems. Where existing technologies do not satisfy higher voltage requirements, new processes and design features are being developed. The results will provide a competitive boost for automotive electronics suppliers in Europe, making them world leaders.**

The consumption of electrical power in a car increased from a few hundred Watts in the 1960s to over 1 kW in the 1980s and to 2 kW in 2000 and is expected to continue to grow in the future. This is due to the fact that the number of electrical and electronic components installed in a car has been significantly enlarged – for example in the improvement of safety, comfort, engine control and exhaust emission. Consequently, the costs for vehicle electronics are expected to reach one third of the overall production costs of a car within the next decade.

A further increase in the electrical current would result in an unacceptable level of thermal losses and in the addition of weight and volume of the wiring. Therefore standardisation activities are continuing to increase the voltage supply of the electrical generator in the car to 42 V, charging a battery that works at 36 V.

Suppliers of automotive electronics will have to develop new 42 V application-specific integrated circuits (ASICs), which operate partially in a much more hostile environment than consumer products and for which the requirements for reliability are drastically higher than, for example, those for mobile phones.

## Identifying technical advances

The MEDEA+ T122 SC42V AUTOMOTIVE project is starting by probing the weak devices in existing ASIC designs, which would not withstand a voltage increase from 14 to 42 V. For these devices, new solutions have to be developed to overcome deficiencies and to improve the quality of ASIC design for future automotive applications.

The three project partners are investigating how current technology platforms can be optimised or enhanced to produce such devices by defining and demonstrating how they can work safely in different operating conditions. The results of the investigations on issues such as voltage and temperature limits, and substrate currents will indicate clearly the critical technical points in future semiconductor processes.

## Pooling ASIC know-how

Designing 42 V-compatible ASICs is a global challenge. Development activities are planned, or in progress, worldwide. The SC42V AUTOMOTIVE consortium combines the knowledge and experience of system design company Robert Bosch with that of technology suppliers AMI Semiconductor (formerly Alcatel Microelectronics) and STMicroelectronics, which are providing their smart power process platforms for the project. These platforms combine the power stages of several amplifiers with analogue input/output functionality and digital processing.

Project leader Robert Bosch, as system supplier and typical user of such smart power processes, brings experience in the design and evaluation of automotive building blocks to the project.

STMicroelectronics obtained much experience of these power processes with Robert Bosch in the earlier MEDEA T508 project. Participants in that project developed a 0.35 µm smart power process, which could produce very advanced system-on-chip (SoC) circuitry containing an embedded microcontroller and memory. AMI Semiconductor has developed a similar technology on a 0.7/0.6 µm CMOS platform; the capabilities of this technology need to be enhanced to incorporate additional logic.

## Cost-effective HV devices

It has also been shown that a standard 5 V CMOS process can be used to implement high voltage (HV) MOS devices. This can be achieved by developing suitable device architecture – such as an extended drain – using the mainstream CMOS process. HV CMOS processes are not able to drive power stages – they are limited to approximately 100 mA – but adding a device for a low power but high voltage interface can cover many applications.

These processes are very cost effective because they use a small number of masks and process steps, especially by comparison with smart power dedicated processes. If suitable system segmentation can be found, smart HV CMOS processes could offer an economic alternative solution.

Much research is required on this whole set of semiconductor processes to produce robust and reliable chipsets. Effective screening procedures are therefore very important. There is a zero-failure philosophy, with a target value of much less than 3 ppm, surrounding the fabrication of automotive ASICs. Today's screening methods are based on costly burn-in methods. HV screening could be effective in reducing the field failure rates.

Quiescent current testing (IDDQ) has been successfully used to ensure higher outgoing quality and reliability of CMOS devices. In sub-micron devices, conventional IDDQ testing is no longer suitable due to the sub-threshold current. So alternative test methods, such as transient current testing (IDDT) and spectrum testing, have to be developed and improved for production applications.

## Taking on the world

The MEDEA+ SC42V AUTOMOTIVE project represents an important milestone for the European microelectronics industry, which enjoys a very strong competitive position in the global automotive electronics market. The worldwide automotive semiconductor market reached around € 13 billion in 2001 and is forecast to grow to an estimated € 19 billion by 2005.

Competition is tough. Among the top ten companies in automotive semiconductors for the European market, there are four US companies (Intel, Motorola, Texas Instruments and Vishay), two Japanese (NEC and Toshiba) and four European (Bosch, Infineon, Philips and STMicroelectronics). Based on 2000 sales data, the European market leader is Infineon, followed by Motorola, STMicroelectronics in the number three slot, Robert Bosch at number four and Philips at number five.

In 2001, US companies held about a 38% share of the world market, followed by European companies with a 32% share. Japanese companies, having gained market share in recent years, were very close with 30%. It is however expected that European companies will grow significantly faster than their US counterparts. Thus one can assume that world leadership of the automotive semiconductor market will soon switch to European companies.

The MEDEA+ T122 project is therefore contributing to the pool of European know-how in automotive ASIC design and places the consortium's partners in a strong position to face the new challenges of 42 V power architecture. Combined with Europe’s strength in automotive production, such a technological breakthrough will have positive impacts on job creation and the state of employment in Europe.

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