PROJECT PROFILE

A407: Failure mechanism driven qualification for reliability and analysis of electronic components (FdQ)

AUTOMOTIVE ELECTRONICS

Partners:

AMI Semiconductor
Atmel
EADS
IMEC
Infineon Technologies
Philips
Siemens VDO
STMicroelectronics

Project leader:

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Countries involved:

Belgium
France
Germany
The Netherlands

Electronic devices are playing an ever growing role in highly demanding automotive applications – particularly in terms of improved safety and comfort. However, as semiconductor technology for use in vehicles becomes more and more complex, the need to understand and identify failure mechanisms has become vitally important. The MEDEA+ FdQ project involves the whole automotive industry value chain in addressing this issue by developing a failure-mechanism driven qualification methodology for the reliability and analysis of electronic components. Establishing and standardising this method on a broad European basis will provide important technical and competitive advantages in the global market.

Approximately 80% of all innovations in the automotive industry are currently influenced by electronics or are even only made possible using such technology. The electronics development and manufacturing sector now creates 25% of automotive added value. Moreover, the automotive industry and its suppliers make the highest demands on the quality of components produced by the semiconductor industry – less than a 0.5 parts per million (ppm) failure rate – with simultaneously increasing requirements for performance, harsher environmental conditions and shorter product cycles.

The ability to offer innovative, qualified and cost-optimised products to the market in good time is more than ever a prerequisite for the preservation of competitiveness within the combined semiconductor and automotive industries. This leads to the fact that the traditional procedure for product qualification – stress-test driven qualification methodology – is now being challenged.

Innovative methods required

Sequential methods of qualification – such as technology qualification after technology development or product qualification after product development – demonstrate their physical limitations as well as their constraints in terms of time to market and cost. For that reason, the semiconductor industry worldwide is looking for new, innovative methods for the qualification of components.

Existing, commonly used test and qualification procedures will not meet the requirements of the near future in terms of cost and time to market, while the currently applied failure testing techniques will lose their validity under changing conditions.

The MEDEA+ A407 FdQ project is therefore developing a better understanding of failure mechanisms, their effects and interactions to provide a more detailed and more efficient reliability forecast as it is important to know how these failure mechanisms relate to technology and product performance. Stress-test driven qualification used today lacks in specifics, whereas a failure-driven methodology has the advantage of being very flexible, specific and accurate, providing the ability to interpret failures rapidly and reliably.

Recognition of failure mechanisms, presence of suitable failure models and failure indicators, as well as of suitable failure

analysis procedures are the basic requirements for such a failure-driven qualification methodology and the compilation of a knowledge matrix. New technologies and the increasing integration of semiconductor devices mean that additional research is required in the area of process technologies for failure localisation, failure preparation and failure analysis. For example, an increasing number of metal layers in highly complex devices or flip-chip technology makes failure analysis impossible with conventional testing procedures.

Practical solution

A failure-driven qualification methodology seems to have considerable potential as a practical solution. Based on well-known failure mechanisms, an efficient and preventive qualification strategy to avoid failures has to be developed, standardised and implemented for the benefit of automotive industry customers and the semiconductor industry as a whole.

However, such a methodology requires very detailed knowledge of possible failure mechanisms as well as basic research on the physical fundamentals and effects. As innovative development approaches its technological limitations, the more important it is to have additional detailed information not only about failure mechanisms but also about interaction between the various types of failure mechanism.

The major goal of the MEDEA+ FdQ project is therefore research into the realisation and establishment of an innovative, comprehensive failure-mechanism driven qualification methodology for the reliability and analysis of electronic components. By moving away from rigid stress-test driven qualification methodology towards a knowledge-based qualification methodology, the project partners and particularly the semiconductor industry are aiming to enhance the ability to meet more stringent requirements within the automotive and other industries.

Standardised procedures

Carmakers' future quality objectives will only be achieved by implementation of a standardised knowledge-based procedure, especially as this has to take place with a minimum of effort. However, such a procedure assumes a very deep understanding of the interactions between the technology, the requirements and the physics of failure.

Based on diversified research activities, failure mechanisms have to be clearly recognised and systemised while functional models have to be provided. The goal is the creation and compilation of a knowledge matrix. Using such a matrix, it will be possible to compare requirements and capabilities at an early stage of technology development, to analyse possible failure mechanisms at a preliminary stage in parallel with product development, to define effective measures for qualification and to avoid future reliability problems.

Main initial objectives of the FdQ project are to complete the definition of application requirements and to finalise the assessment of the qualification methodologies and the required failure-analysis techniques. They also involve selection of the most promising alternatives, the launch of experiments and their evaluation. This will be followed by the step-by-step assessment of innovations regardless of either the qualification strategy or the failure-analysis technique.

Setting world standard

Developing and evaluating the failure models and test results in close co-operation with microelectronics suppliers is essential for the development of understanding and customer acceptance.

A major intention in FdQ is to create a *de-facto* industrial standard for acceptance of the qualification procedure by chipmakers, system suppliers and client industries. This methodology will be defined through the auspices of the relevant standardisation committees such as the AEC, JEDEC and IEC worldwide and is expected to become a common standard, established by the European semiconductor industry.

The FdQ consortium brings together European partners from the entire vertical value chain from automotive system suppliers to chipmakers to meet the requirements of the global automotive industry.

Development of qualification strategies in this MEDEA+ project that rise to the challenge of new technologies will guarantee electronics systems that satisfy the highest quality and reliability standards in automotive applications essential to improve road safety and reduce accidents. Establishing and standardising this method on a broad basis will provide European suppliers with important technical and competitive advantages in the global market.