

Definition of reliability qualification tests of electronic components for active implanted medical devices

Host laboratory: LARIS Laboratory – Dependability and decision support team (Polytech'Angers - University of Angers)

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Duration: 12 months from March 2023
Type of offer: Post-Doc
Contract: CDD
Remuneration: 2840 Gross (2 282 € net) monthly
Employer: LARIS - University of Angers
Location: Angers (France)
Specialty: Engineering sciences

Keywords: Electronics, Microelectronics, Medical Devices, Reliability, Qualification, Reliability testing.

Industrial context

TRONICO designs, industrializes and manufactures complex products with a predominantly electronic component that can be found in all fields, particularly in the health sector. As a result, new medical systems implemented in development must demonstrate a high level of reliability in a specific (humidity...) and constrained environment [1]. The use of electronics is regulated by numerous documents that deal with electro-medical devices, often called Medical Devices (MD). In these documents, the reliability of electronic components is not explicitly addressed. Nevertheless, there are some indications, for example [2]:

- **Component with high reliability characteristics:** component that, due to its characteristics, cannot present a defect compromising the safety of MDs.
- **First fault condition:** the MD is in a first fault condition when an anomaly occurs (typically a technical failure). The first defect conditions of the means put in place to reduce the risks will be carefully examined.
- **Lifetime:** the period of use defined by the manufacturer.

Currently, there is no standardized process for qualifying electronic components for medical applications. Product designers often look for components that have been qualified for other fields such as the automotive, military or aeronautical industries, where the tests carried out have verified their robustness or safety level (ASIL, SIL) in relation to their manufacturing process [3].

Some component manufacturers offer a medical range. This often involves selecting components from the commercial, automotive or military range and keeping only those components that meet the more stringent criteria after more severe tests.

The testing of "medical" electronic boards is a major challenge to reconcile different aspects: Technical, Cost, Reliability and Safety ([4] and [5]). These tests must therefore be addressed and designed from the first phases of the design of electronic boards.

Objective/Research topic

Within the framework of the regional project RECOME (Reliability of Electronic COmponents for MEDical devices), the purpose of this research work is to define a methodology to qualify an electronic component to respect a level of safety of MD. It will be a question of defining the tests to be carried out according to the type of components and the medical application.

This study will be based on the various standards for the qualification of components and/or their manufacturing process, on the requirements for the safe operation of medical devices, and on the ageing models for electronic components. It will have to evaluate, if necessary, processes of implementation of these components allowing to increase their reliability in application (underfill, coating...) with technological locks and in particular the miniaturization and the impossibility of carrying out traditional tests (functional tests, tests in situ).

This post-doctoral fellowship aims at applying the methodology, based on the design of experiments [6] and established during the current thesis work, to several types of components including integrated circuits and MEMS accelerometer. This consists in defining accelerated test plans from the study of the failure mechanisms and the mission profile specific to active implanted medical devices [7], to define the associated test protocols, and then to analyze the observed failures. The results will allow the definition of a reliability model by family of components according to the design characteristics.

Subsequently, it will characterize the impact of implementation processes (underfill, coating) on the reliability of a product that are not yet quantified [8], [9].

In order to achieve this objective, the principle envisaged is (by mission profile and by component technology):

- To identify the weaknesses of the component and the failure modes by feedback or by research analysis,
- To define qualification and validation processes for components,
- Define reliability demonstration methods based on accelerated life tests ([10], [11], [12] and [13]).

The research carried out will bring an innovation on the recent processes of manufacture and integration of electronic embedded systems of miniaturization. It will allow on these evolutions to improve the implementation of a component in a product to optimize its reliability.

It will allow to establish predictive models of the physics of failure associated to guarantee the reliability of a couple product / process. This research will lead to a gain in



competitiveness by limiting the costs of qualification and testing of components by precisely defining the "right need".

A valorization of the scientific work is to be carried out in particular in reviews like [Microelectronic reliability](#), [Reliability Engineering and System Safety](#), [IEEE Transactions on reliability](#) or [IEEE Transactions on device and materials reliability](#).

Location of the thesis:

The candidate will be geographically located on the site of Polytech'Angers/University of Angers in Angers and travel will be required on the site of TRONICO in Nantes / St-Philbert-de-Bouaine.

Candidate profile:

The candidate should have a PhD specialized in the field of engineering sciences, microelectronics or possibly in applied mathematics with a first experience in reliability. It is desirable that the candidate for this position has:

- knowledge of reliability estimation,
- knowledge in electronics,
- experience in dependability,
- ability to work in a team, to communicate and to write scientific documents (multidisciplinary team including 3 researchers, 1 PhD student),

The profile is voluntarily broad and can be refined according to the skills of the selected candidate.

The candidate will have to manage a balance between academic research and research and development as well as the realization of laboratory tests in the academic and industrial environment.

Evaluation of the breakdown of activities

Bibliography (15%), Modeling (25%), Simulations (20%), Experiments (25%), Thesis and Articles (15%)

Training/skills required:

Electronics and microelectronics,
Reliability tests,
Reliability testing, operational safety,
Optimization and statistical control of processes.

Application deadline: 30 May 2021

Presentation of the recruiting institution:

The Laboratoire Angevin de Recherche en Ingénierie des Systèmes (LARIS) is a host team EA7315 of the University of Angers, composed of 3 interconnected teams:

- Dynamic Systems and Optimization (SDO)
- Information, Signal, Image and Life Sciences (ISISV)
- Dependability and Decision Support (SFD)

The current staff is:

- 54 teacher-researchers including 24 HDR
- 3 research engineers and 1 project engineer
- 1 administrative and financial manager
- 30 PhD students
- 1 post-doctoral student, 1 temporary teaching and research assistant

LARIS brings together researchers from four components of the University of Angers (Polytech'Angers, IUT, UFR Sciences, ESTHUA), the CHU, the UCO and the ESAIP. It is a stakeholder in the Pôle Math-STIC of the University of Angers.

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