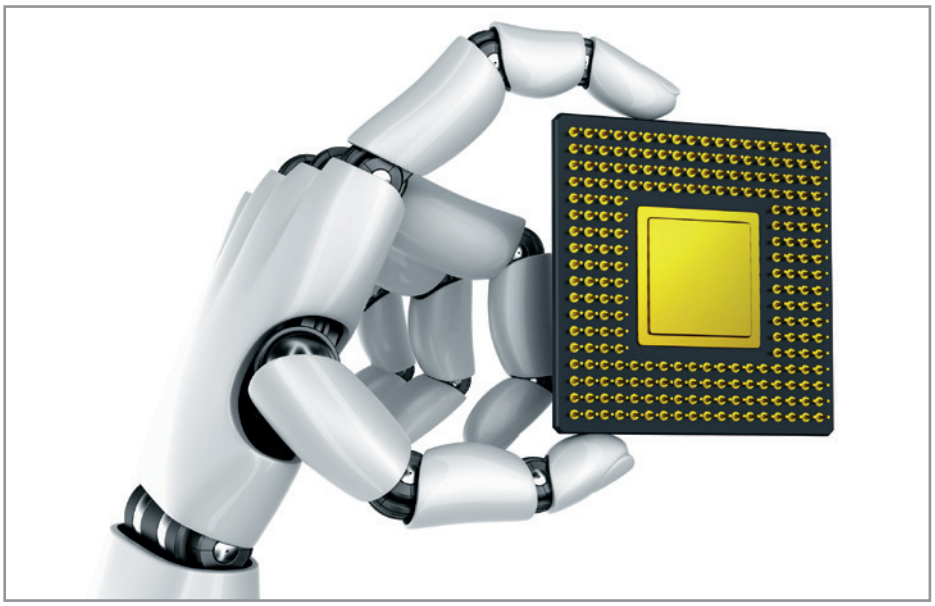
Fraunhofer IIS

FlowCAD

Theranostic Implants



Myoelectric Hand Prosthesis

Theranostic Implants

Theranostic implants are complex, multifunctional, implantable medical devices that combine **thera**py and diag**nostic**s in one medical system. Detection of specific vital parameters is the diagnostic reference for therapeutic treatment. Efficiency of this initiated treatment is optimized in a closed feedback loop with measurements of the implant.

The importance of theranostic is currently growing due to its diverse application possibilities. Demands on quality of highly specialized medical care and the demographic change are increasing.

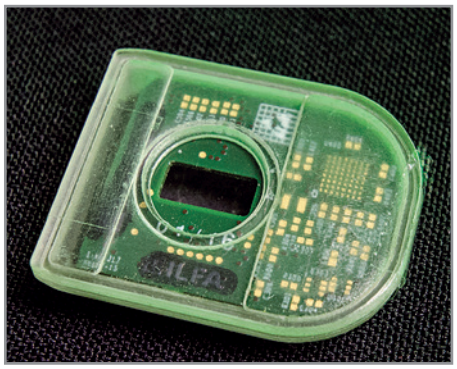
Theranostic implants have achieved a social relevance leading to an innovation leap in medical technology in the context of future technological possibilities.

For quite a while individual Fraunhofer institutes are making already significant contributions to such innovation based on the combination of multiple technologies at a high level. Fraunhofer-Gesellschaft is able to take a leading position by concentrating these different activities in key technologies that are important for theranostic implants.

This prototype described here is an implant for controlling a myoelectric hand prosthesis with at least six degrees of freedom and a sensor feedback. The primary purpose of an myoelectric arm prosthetics is to mimic the appearance and replace the function of a missing limb.

Signals are tapped in a multichannel manner from the muscles to control the prosthesis. Gripping force feedback of the artificial hand is transmitted to the person via an electronic stimulation of the sensitive nerve fibers.

Application-specific integrated circuits (ASIC) were developed at Fraunhofer Institute IIS in Erlangen to detect electrical activity of muscles and to stimulate the nerve fibers.



The PCB is fitted into a 3D prototype housing

Fraunhofer Institute for Integrated Circuits IIS in Erlangen

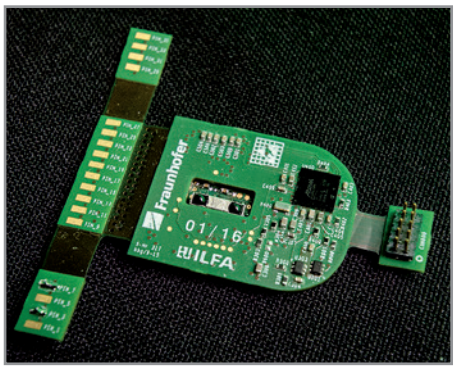

Alfred Holzberger, Senior PCB Designer

Challenges

Implant size is the biggest challenge determined by the position within the body and it is already defined before the beginning of the actual development. Designers are influenced to achieve the intended design ultimately to reduce implant functionality or to choose an extremely compact design.

Electronics is used to control the hand prosthesis with active feedback to the ASICs. Installation space for electronics was already predetermined in advance by the size and shape of the titanium housing with enclosing silicone encapsulation. Optimal use of installation space could only be achieved by constructive measures in housing design or by component shifts or component selection.

Common practice of building up a prototype for the first time in order to keep all possible degrees of freedom open and to communicate with the outside world via various connectors could not be achieved here. The only concession to additional components was a debug plug via a flexible connection, which is separated after the firmware has been programmed.



Variant for optical communication with detachable debug-connector and solder contacts

Therefore, all the available variants had to be accommodated on the implantable board with the dimensions of approx. 21 x 26 mm. A cut out with a size of approx. 4 x 8.5 mm is present in the middle of the circuit board which removes additional wiring area.

The prototype had to include the following possible variants of a later product:

- Inductive charging of the internal energy buffer
- Optional communication via optical interface or
- Communication via RF
- Choice of external signals via contact pins in flex or
- External signals can be fed via fold-in soldering lugs

Used CAD software

For the given task PCB design software from Cadence was used. "With Constraint Manager of Allegro PCB Designer version 16.6 all required restrictions and design rules could be precisely defined and verified during the design process" said Alfred Holzberger.

„The very comprehensive yet manageable Constraint Manager makes it possible to define all the necessary electrical, physical and distance-related rules in a layer-specific manner like geometrical parameters for impedance control, adapted cable lengths for individual signals or buses, keep outs, etc."

The mechanical housing design already existed and could only be modified within very narrow limits. Electronics and mechanics had to be adapted to each other in several iterations and data exchange for collision tests with highest accuracy in MCAD software Inventor.

Nomination PCB-Design Award

For its PCB complexity the designer was honored by the FED at its annual conference in Bonn in September by the nomination for PCB Design Award 2016.

About Fraunhofer

Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. In total 69 institutes and research facilities operate at locations all over Germany.
The Fraunhofer Institute for Integrated Circuits IIS in Erlangen is a world-leading application-oriented research facility for microelectronic and information technology system solutions and services.
Fraunhofer IIS is today the largest institute of Fraunhofer-Gesellschaft.
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