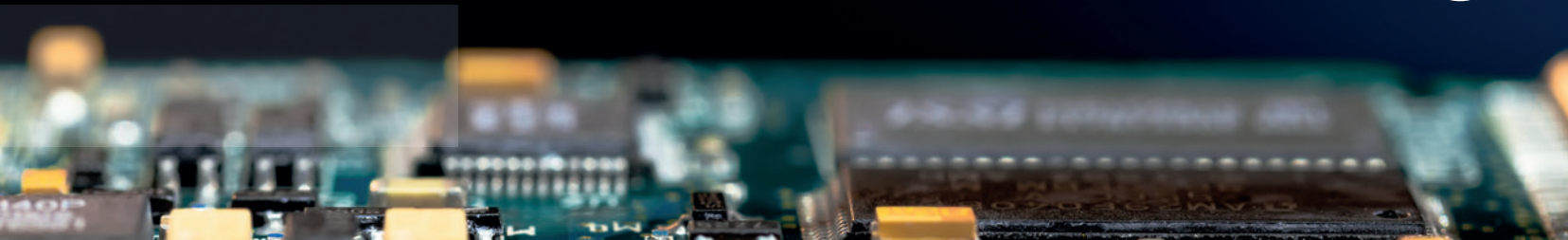




Research and Teaching

for the electronic systems of the future

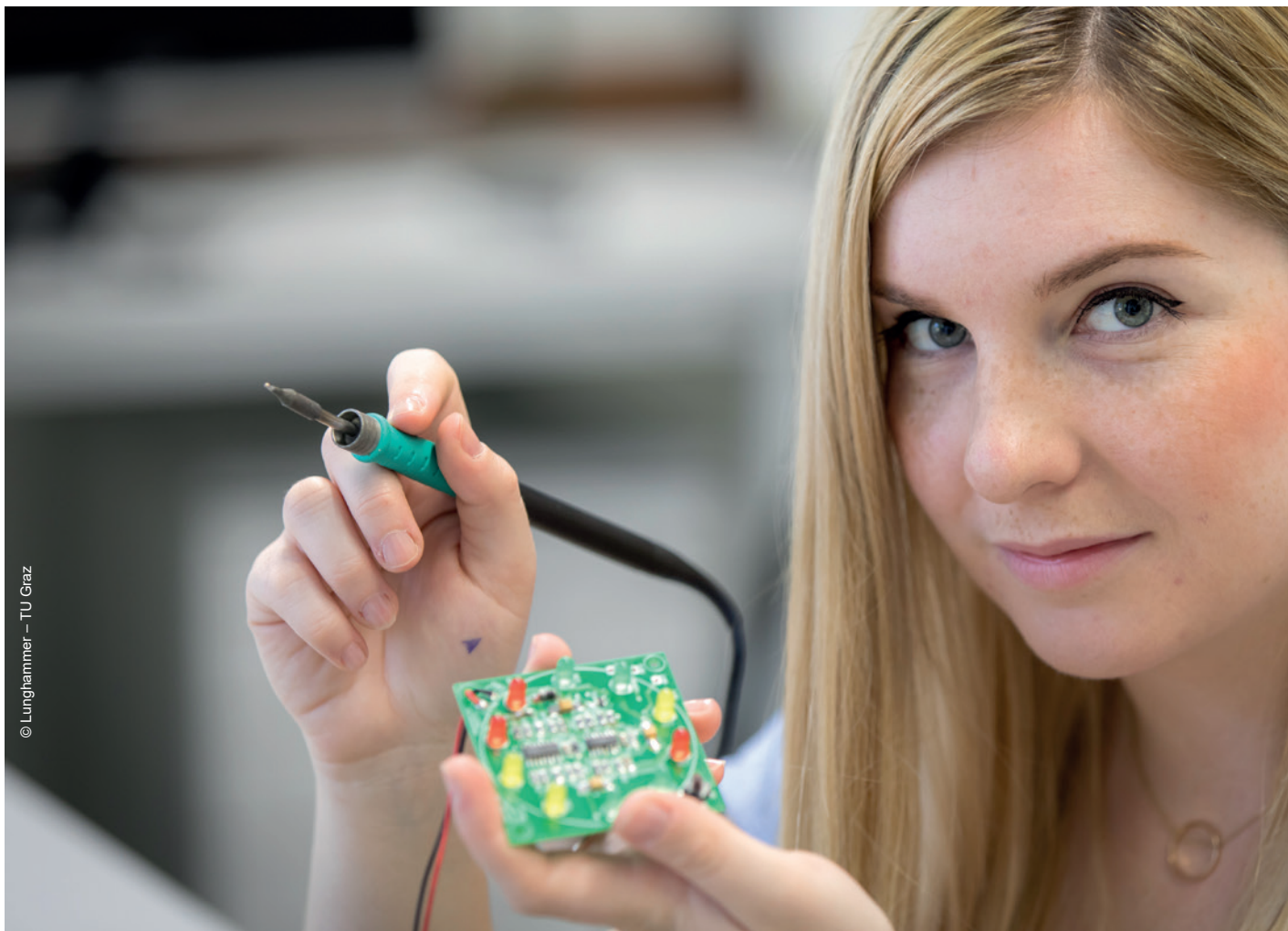


Welcome to the Institute of Electronics (IFE)

The Institute of Electronics was founded as part of the Faculty of Electrical and Information Engineering at Graz University of Technology in 1963. This makes the Institute of Electronics one of the oldest academic research and educational institutions. The know-how of the institute in the fields of electronic circuit design, integrated circuit design as well as electromagnetic compatibility of electronic circuits and systems contributes to the development of more robust electronic systems.

Electronic systems are an essential part in a modern society. The ongoing enhancement of information engineering, spread of internet applications, and human-machine-interfaces has further increased the importance of electronics. Modern electronic systems are comprised of numerous integrated circuits (ICs). Their undisturbed combined operation is crucial for the performance and reliability of the whole system.

The increasing demands on the robustness of these systems, for example against electromagnetic interference, in the areas of radiation hardness, and immunity to transient disturbances such as electrostatic discharges etc. lead to increasingly more complex requirements and challenges. To effectively deal with these challenges, a well-founded knowledge of electronic circuit design and analog IC design is necessary.



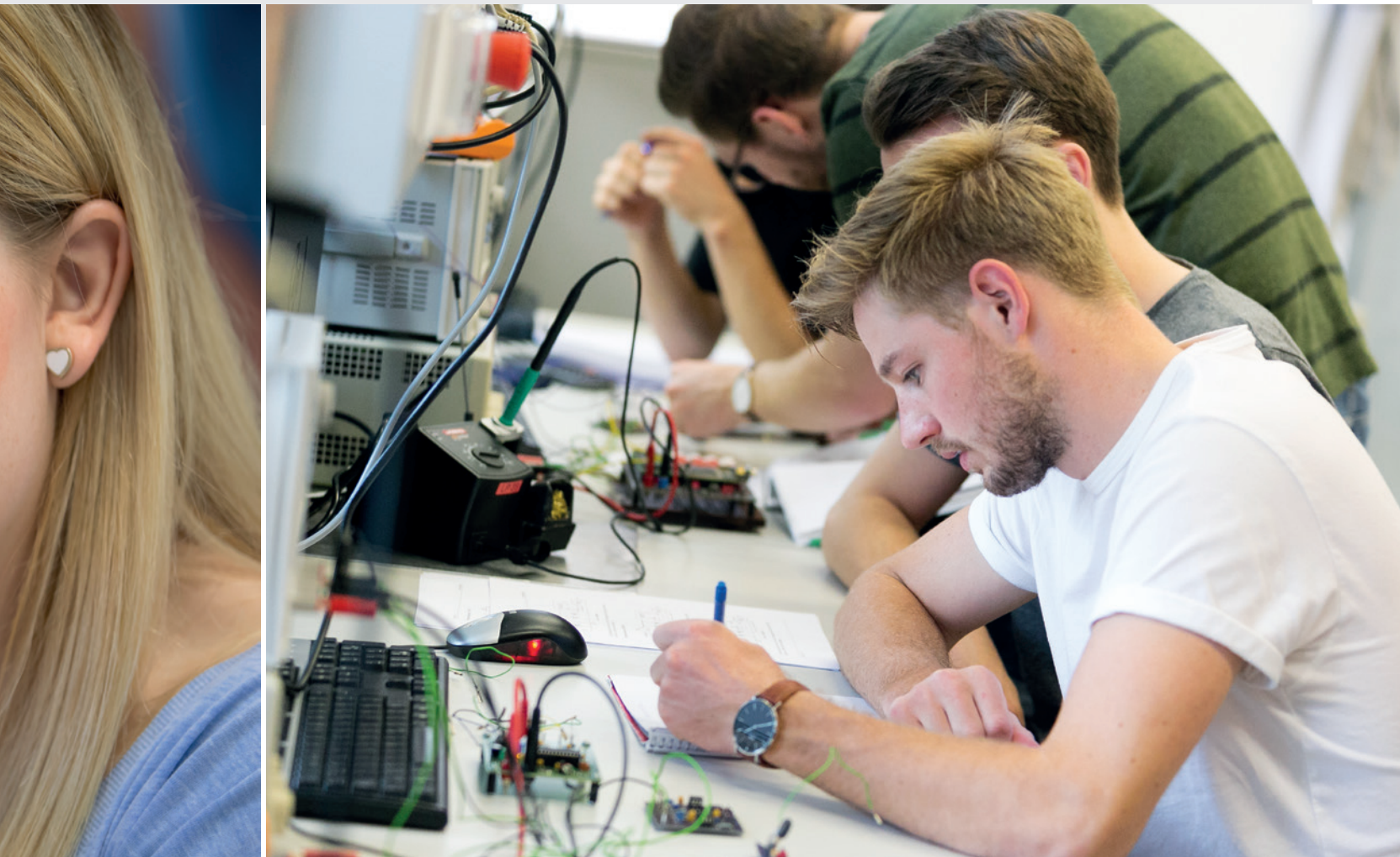
This knowledge is developed at the Institute of Electronics in numerous national and international projects in the field of fundamental-, as well as applied research. It is taught to the approximately 500 undergraduate and 70 master's students annually as well as published in relevant scientific journals.

In addition, for more than 20 years, the IFE has a modern infrastructure for characterizing the electromagnetic emission and immunity of electronic devices, systems, and integrated circuits, which has been successively expanded. The associated services are more called on than ever before from the surrounding industry and from universities.

In this brochure, we would like to give you an overview of the current research in the field of electromagnetic compatibility and microelectronics, the offered courses for students, and the services of our institute. The IFE team is always available for more in-depth questions on all areas.

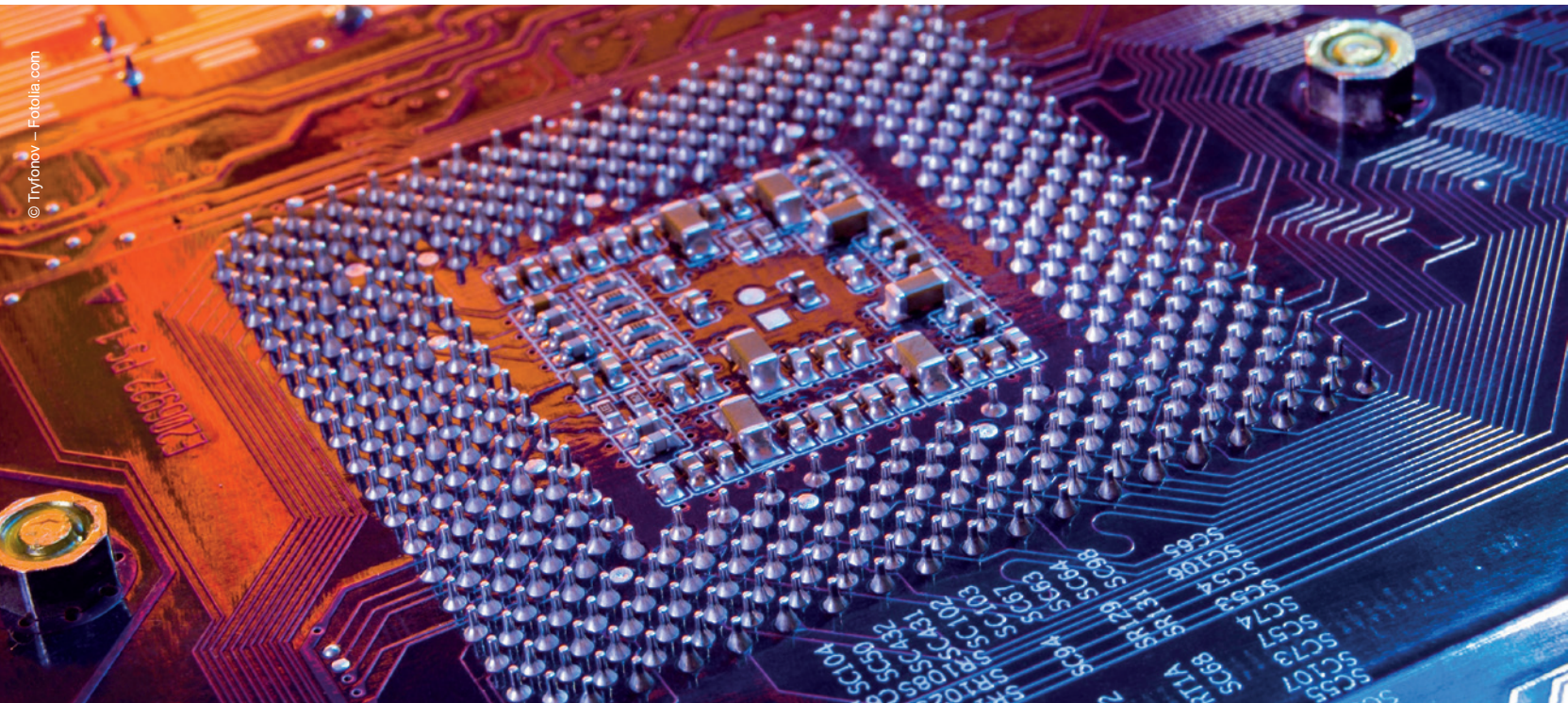


Prof. Dr. Bernd Deutschmann
head of the institute



The research focus of IFE

The research focus of the IFE is in the fields of electromagnetic compatibility and microelectronics. Due to the good and long-term industry contacts, as well as the focus on current research questions of the electronics industry, it has been possible to attract numerous third-party funded projects and thus to promote a significant expansion of the institute in the recent past. In addition, the IFE together with industrial partners from various sectors, conducts numerous research collaborations.



> Research in the field of electromagnetic compatibility (EMC)

Electrostatic discharge

An electrostatic discharge (ESD) is caused by two objects with different electrical potential touching each other. ESD is a short, high electrical current that can damage electronic components and degrade systems. The ongoing trend to move more circuit elements into integrated circuits and miniaturization of those integrated structures further tightens the requirements for ESD robustness. The exact characterization of electronic components and their ESD robustness is one of the research fields at the institute.

Research projects:

- System-level ESD Robustness Estimation Using Wunsch-Bell Model (SERUM)
- RobustIC – Studies on Robustness of analog Integrated Circuits

EMC simulation

With ever-increasing switching frequencies in modern switched-mode power supplies and microprocessors, electromagnetic emissions are rapidly becoming a major issue for many device manufacturers. Since the disturbances that a device may emit must not exceed certain limits, manufacturers are often forced to build a variety of prototypes to cope with these spurs. The simulation methods developed at IFE help manufacturers identify such problems at an early stage, thus reducing time-to-market. For the comparability of simulation and measurement, it is necessary to properly integrate not only a precise model of the device, but also various measuring devices into the simulation.

Research projects:

- Radiated Emission of Integrated Circuits
- FPES2020 – Future of Power Electronic Systems 2020

Research partners:

- NXP Semiconductors Austria
- Fronius International
- Seibersdorf Laboratories
- Infineon Technologies Austria
- Kompetenzzentrum Automobil- und Industrieelektronik (KAI)
- Consulting in Industrial Statistics (CIS)

Power electronics (DC/DC converters)

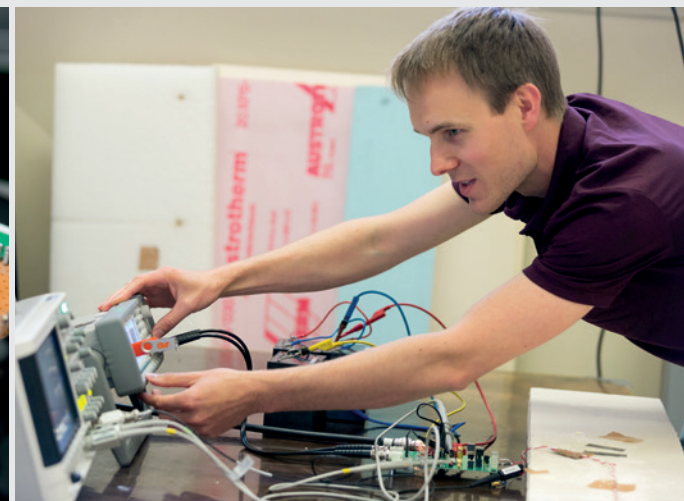
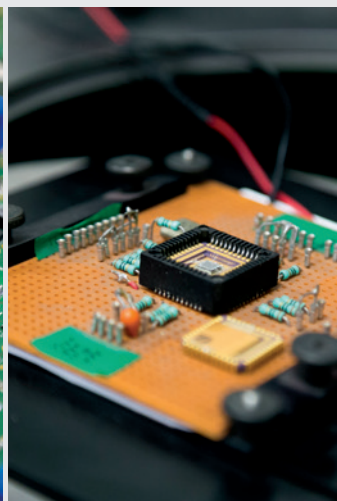
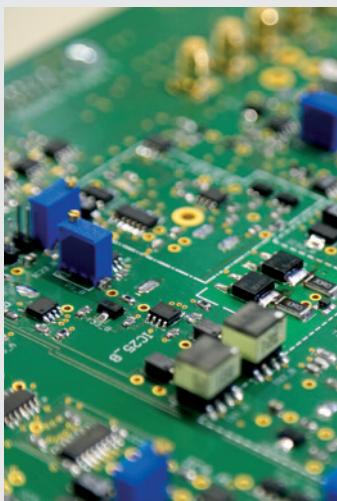
DC/DC converters are electrical circuits which convert a DC voltage supplied at the input into a DC voltage with a higher, lower or inverted voltage level. The switches needed for this conversion cause electromagnetic interference due to ever-increasing switching frequencies, which can affect the function of other components and devices. IFE is researching how future emissions can be significantly reduced. An important tool for this is EMC simulation for predicting emissions during the design phase of electronic devices.

Research projects:

- FPES2020 – Future of Power Electronic Systems 2020

Research partners:

- Fronius International
- Seibersdorf Laboratories
- Infineon Technologies Austria
- Kompetenzzentrum Automobil- und Industrieelektronik (KAI)
- Consulting in Industrial Statistics (CIS)



Mixed-Signal-Design

In the field of mixed-signal design, circuits are developed that decisively determine the signal quality in applications in the field of audio and sensor technology. Robust signal processing blocks are developed, which are realized in terms of power efficiency in the form of integrated circuits. In addition to designing A/D and D/A converters, the entire signal processing chain is also investigated to find an optimized solution.

In the field of audio engineering, the realization of low-emission Class D amplifiers has also recently been considered, and solutions have been studied and developed that feature hi-fi audio quality and low electromagnetic emissions.

Research projects:

- RUBUSTIC – Robust-IC-Studies of Robustness on analog Integrated Circuits
- LEAD – Low Emission Analog Design
- Design of Robust Operational Amplifiers

Research partners:

- Intel
- ams
- USound
- Infineon Technologies Austria

Space technology

In the field of mixed-signal design and radiation-hardness, an ASIC is currently being developed in cooperation with the Institute for Space Research, which will be used for future space missions to measure the magnetic field.

Research project:

- THOR - technical pre-project – Turbulance Heating Observer

Research partner:

- Space Research Institute

Radiation hardness

In the field of radiation hardness of integrated circuits, which plays a particularly important role for the aerospace industry as well as in many medical fields, we investigate the behavior of analog integrated circuits under the influence of ionizing radiation. On this basis, among other things, design guidelines for a robust IC design are developed.

Research project:

- COTOMICS – Computed Tomography IC with high Radiation immunity

Research partner:

- ams

Energy harvesting

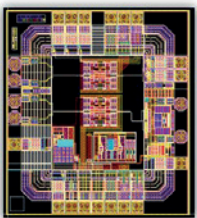
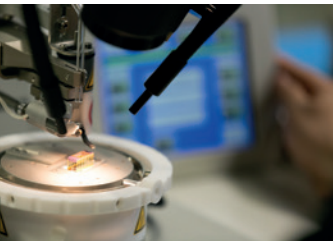
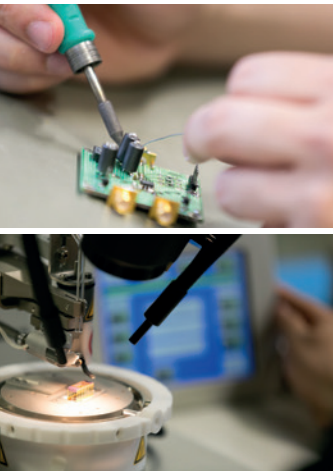
By means of efficient thermoelectric generators and energy storage, it is possible to provide small electronic devices with energy. Potential areas of application are, for example, in medicine for self-sufficient sensor systems (health monitoring). The starting materials for this technology are nanostructured carbons (graphene). In the right modification and combination, they convert waste heat into reusable electrical energy.

Research project:

- EU-NanoCaTe – Nano-carbons for versatile power supply modules

Research partner:

- Infineon Technologies Austria



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Interesse? Melde dich über den Link an, um mehr über die Karrieremöglichkeiten bei der Intel Austria GmbH zu erfahren:
<http://career.intel.com/XPxqu>



The curriculum of the IFE

Teaching activities at IFE cover the complete development process for analog integrated circuit devices and start with basic lectures on electronic circuitry in four different fields of study. There are also related laboratory exercises for the practical deepening of theoretical knowledge. In these elementary courses about 500 students participate per academic year.

Fundamentals of Electronics

- **Electronic Circuit Design**
(digital + analog circuits)
- **Basics of Microelectronics**
- **Circuit Simulation**

Electromagnetic Compatibility

- **Electromagnetic Compatibility of Electronic Systems**
- **Electromagnetic Compatibility of ICs**
- **Evaluation of ICs Laboratory**

Microelectronics

- **IC Design Fundamentals**
- **Analog Integrated Circuit Design**
- **Analog IC Layout**

Building on the basics taught, further courses follow to deepen the knowledge of electronics and of the two main research fields of the IFE: electromagnetic compatibility and microelectronics. A variety of laboratory courses put a strong focus on the practical work. Renowned external lecturers are teaching students in state-of-the-art topics with focus on "Analog Chip Design", which in Austria, apart from the IFE, only a very few universities can offer in this form. "Selected Topics of Advanced Analog Chip Design", a course taught by international guest lecturers who focus on different topics every year, serves as an example.

Overall, the IFE has one of the most comprehensive teaching portfolios offered by the Faculty of Electrical and Information Engineering. Bachelor-, Master- and PhD-theses are often carried out in cooperation with industrial partners. At IFE, there are also regularly outgoing and incoming teaching activities. For the better preparation for the professional life, all courses in the Master's program are held in English, which is also reflected in the attempt for internationalization at Graz University of Technology.



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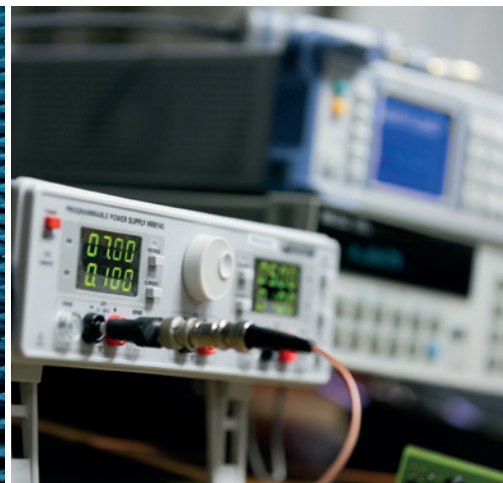


Modern-day facilities for students

The IFE has a modern infrastructure that is constantly being expanded and adapted. 24 new power supplies, oscilloscopes, multimeters and function generators are available for students in the numerous basic laboratory exercises. The CAD room offers 14 new high-end PCs with Linux operating system and dual monitor equipment in order to learn everything about IC design using Cadence, Synopsys and Mentor Graphics.



The possibilities for characterization of electromagnetic compatibility of electronic devices and systems as well as integrated circuits, which the institute has been offering for more than 20 years, have also been successively expanded. A so-called surface scan-system has been acquired and further developed, which makes it possible to determine the cause of interference and interference-immunity problems of printed circuit boards and ICs. In addition, the institute has various mechanical and electronic engineering devices available for the production of prototypes. This includes a bonder for connecting integrated circuits, as well as a printed circuit board production and modern soldering stations.





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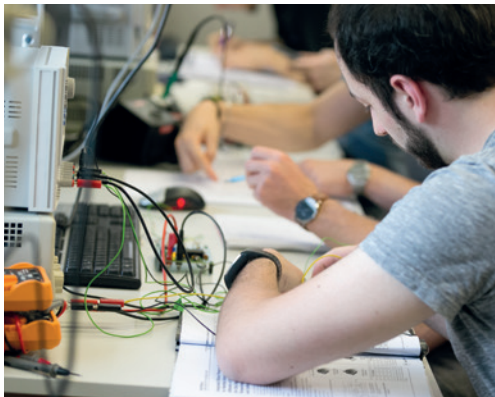
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Services – for students and companies

The technical equipment at the IFE is available to students. However, more and more companies from the region are also taking advantage of the various opportunities offered by the IFE regarding electronic measuring systems for the characterization of EMC properties for their own research.



Workshop

Electrical workshop/equipment

- SMD soldering station with camera microscope
- Hot air repair station
- ERSA precision placement system
- Vapor-phase soldering machine
- Components inventory

Printed Circuit Board Production

- Photo plotters
- CAD milling machine
- 2 laminators
- Etching plant
- Electroplating plants for through-hole plating and coating of film material

Mechanical workshop

- Turning lathe
- Milling machine
- Drilling machine
- Inert gas welding unit
- Folding machine
- Bending device for sheet metal
- And much more....

Labs

Project laboratory

- Used for bachelor and master theses
- High-quality laboratory equipment
- Soldering station
- 3 CAD workstations for PCB design/firmware development
- 5 laboratory places

Student lab

- Used for a total of 7 laboratory tutorials
- 24 laboratory places (modernized in 2015)
- Re-equipment of measuring instruments in 2015
- Per laboratory place: power supply, oscilloscope, function generator, multimeter

Integrated circuits

- 14 high-end PCs with Linux
- Each with double monitor equipment
- Presentation equipment for lecturers
- Netzwerkdrucker
- CAD software for IC development: Cadence, Synopsys, Mentor Graphics

Microelectronics

Probe Station

- Suss probe station
- 4 passive probe holders
- Laser cutter

IC evaluation

- High quality and high precision laboratory equipment with special equipment, like logic analyzer, RFID measuring station, etc.

IC Manufactory

- Wire bonder

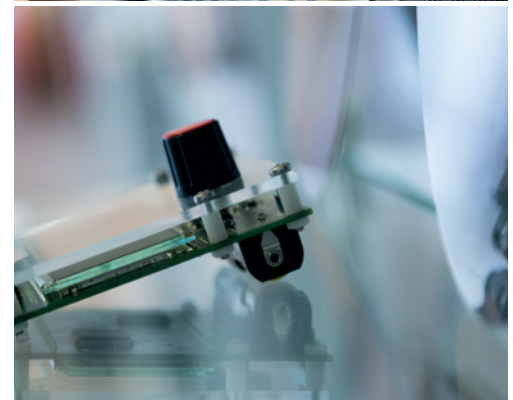
Electromagnetic compatibility

Surface Scan

A surface scan system is based on the measurement of the magnetic field and electrical field of printed circuit boards or microchips. It enables the visualization of the distribution of magnetic and electric fields, which appear directly on the surface of printed circuit boards. Using this procedure, you can detect the causes of emission and immunity problems.

Interference immunity and immunity measurements

To characterize the emission of interference, different measuring receivers (EMI receivers), coupling networks, striplines, several shielding cabins as well as an absorber hall are available. In the field of immunity measurement, the institute can offer numerous measuring instruments, such as ESD generators, burst and hybrid generator, RF interference measuring stations for measuring conducted and radiated interference, as well as a DPI measuring station for characterizing the immunity of integrated circuits.



Sponsors

- ams
- Intel
- Infineon Technologies Austria
- NXP Semiconductors Austria
- Dialog Semiconductor

Events at IFE

The IFE organizes numerous events every year. These include, among other things, visits to trade fairs and specialist seminars and excursions to leading companies, e. g. from the semiconductor industry and other companies from the area of electronic systems. The EMC symposium “EMV-Fachtagung” is also attracting national attention.



The EMC symposium will take place every two years, alternating between Seibersdorf Labor GmbH and Graz University of Technology and has become an annual event for the exchange of experience and ideas within the EMC community.

It serves to impart practice-relevant EMC knowledge and information about innovations within the industry. This most important EMC event in Austria celebrated its 15th birthday in the spring of 2017. The Institute for Electronics was the responsible organizer in 2017 together with the OVE Academy, the Austria Chapter of the IEEE EMC Society, and Seibersdorf Laboratories. The approximately 150 participants enjoyed lectures and technical presentations, as well as a very successful evening event at the Nicola Tesla Laboratory of Graz University of Technology and a visit to an exhibition area where important companies of the EMC sector revealed their latest products.



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