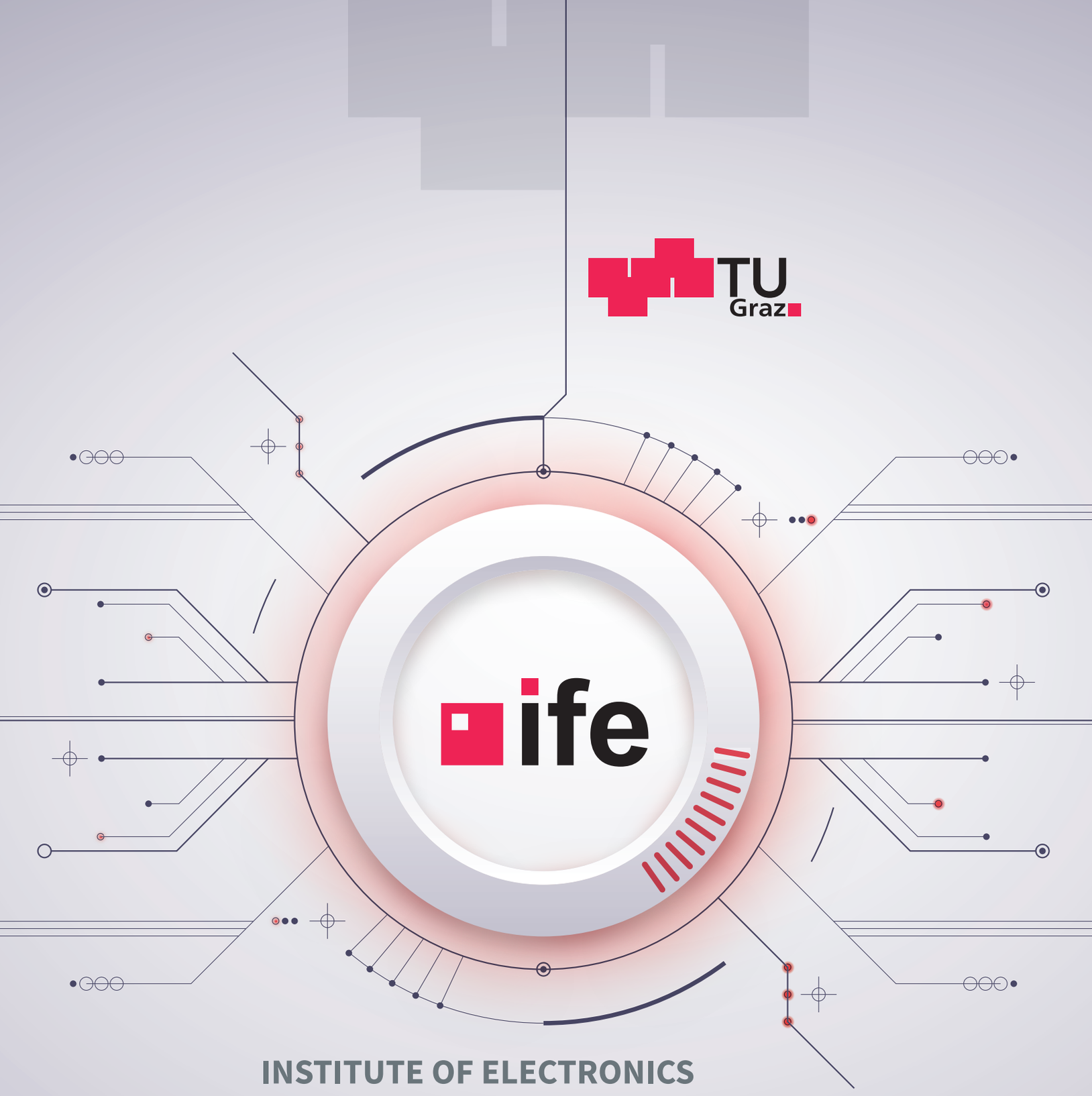


INSTITUTE OF ELECTRONICS

#electromagneticcompatibility
#analogchipdesign
#radiationhardness
#electrostaticdischarge
#weloveeducation

Welcome to the Institute of Electronics (IFE)

Dear Readers,

Electronic based systems (EBS) are becoming increasingly important in our modern world. It is no longer possible to imagine many areas without them. With the constant development of information technologies and their increasing use for communication between people and machines, the importance of electronics has increased greatly in recent years. Modern EBS often contain a multitude of integrated circuits (ICs), whose undisturbed interaction with each other decisively determines the performance and reliability of the overall system. The increasing requirements in the field of their robustness and immunity against environmental effects, such as electromagnetic interferences (EMI), transient disturbances such as electrostatic discharges (ESD) for example, as well as requirements regarding harsh environments e.g. temperature, mechanical stress or radiation, lead to more and more complex scientific tasks and challenges. To master these, special knowledge of electronic circuit design, microelectronics or analog and mixed-signal IC-design but also knowledge of electromagnetic compatibility and radiation hardness of ICs and electronic systems is required.

Such knowledge is developed at the Institute of Electronics (IFE) in numerous national and international research projects; both in fundamental and applied research, and is made available to approximately 500 undergraduate and 70 master's students annually. The scientific results are published in relevant scientific journals and are presented at important national and international conferences, symposia and workshops.

Looking back on the past years since I took over as head of the institute in March 2014, the conclusion is very gratifying. The institute has developed and positioned itself very well in recent years around its main research areas. In the field of teaching, the institute currently offers 52 different courses (26 in Winter Semester, 26 in Summer Semester) within the bachelor, master and PhD programs in the branches of study Electrical Engineering, Information and Computer Engineering, Biomedical Engineering and Digital Engineering.

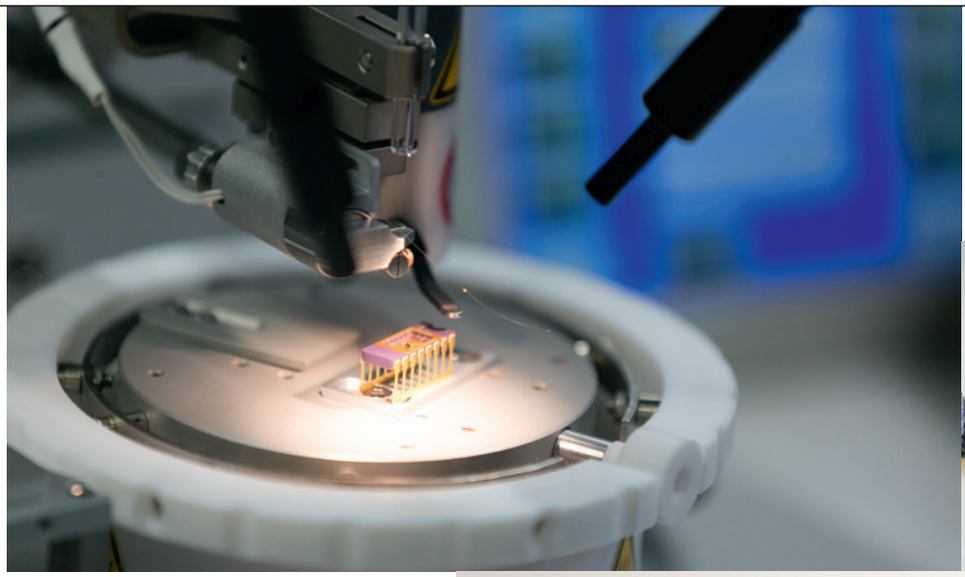
The infrastructure available at the institute in the area of development and characterization of electronic devices and systems, especially the infrastructure in the area of the EMC laboratory for the characterization of the electromagnetic emission and immunity of EBS as well as ICs has been successively extended in the last years. This is more than ever in demand in the course of research cooperation with industry and cooperative projects with other universities.

I owe special thanks for the thoroughly positive development of the institute to my staff. They are the backbone of the institute and their tireless efforts and valuable contributions in research and teaching are the reason for the institute's success. I would also like to thank my colleagues within the faculty and at Graz University of Technology for their excellent cooperation and look forward to further joint projects.

My special thanks also go to the research partners, the supporters from the surrounding semiconductor industry as well as the funding agencies.

In this brochure, we would like to give you an overview of the current research areas, the courses offered for students and the infrastructure of the institute that we are happy to provide for joint research activities. I am very pleased if I have succeeded in showing you what developments and research there are at the Institute of Electronics and what possibilities it offers for future joint research activities.

Univ.-Prof. Dipl.-Ing. Dr. techn. Bernd Deutschmann

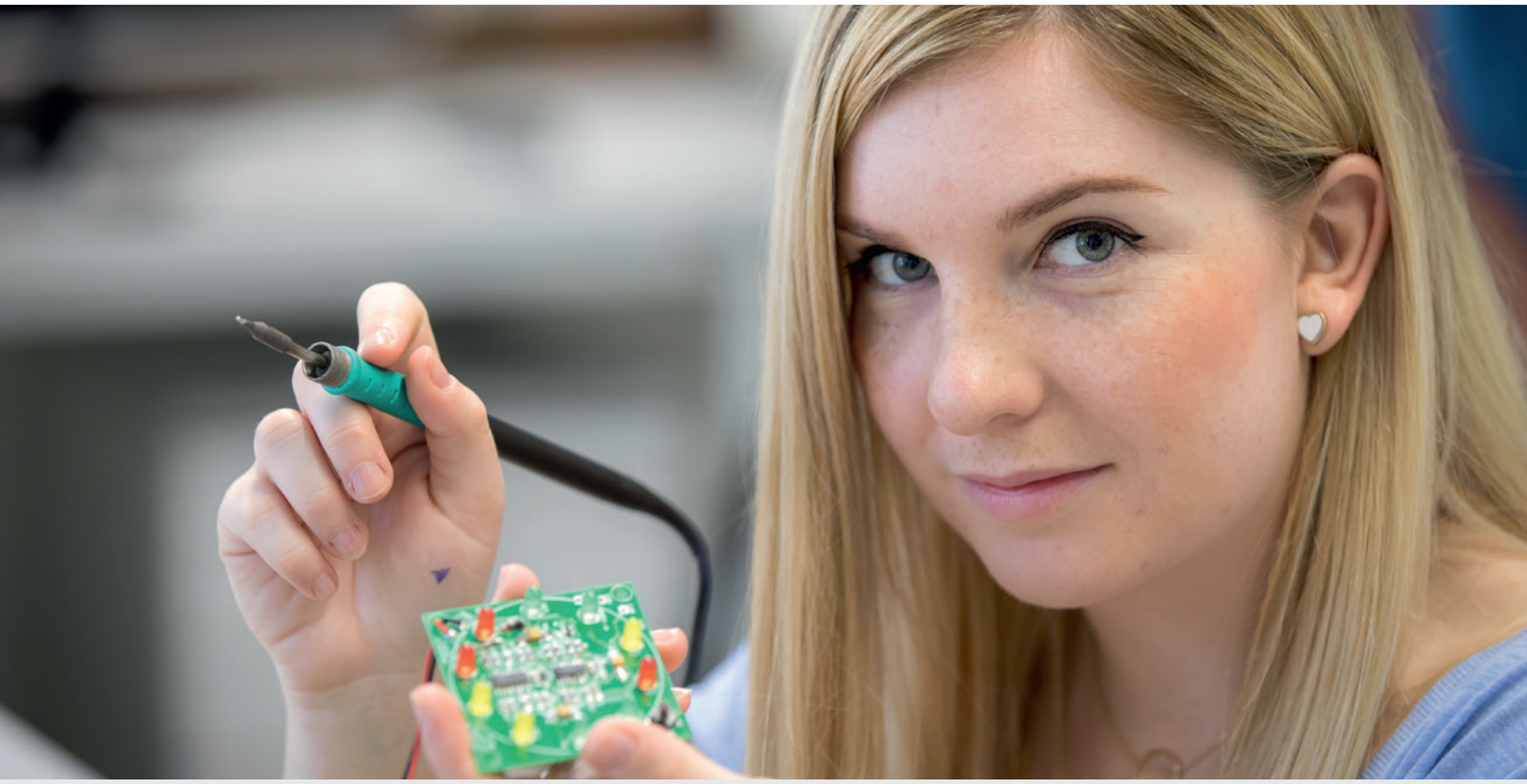


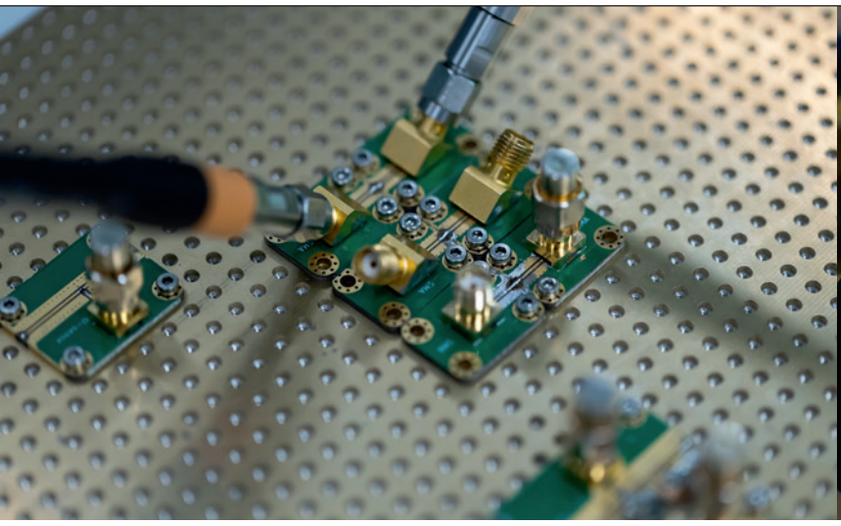

ife


TU Graz

» Research Fields

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 conducts numerous research collaborations together with industrial partners from various sectors.





Immunity of Microelectronics

Electronic based systems, especially when they are used in automotive or industrial applications, are often entrusted with various safety related issues in order to reduce the risk of physical injury or damage to the health of people [1]. Therefore, their correct functionality under all circumstances and especially under harsh electromagnetic environmental conditions is very crucial.

In order to avoid such interference problems, several research projects at the Institute of Electronics focus on improving the immunity of integrated circuits to radio frequency interference (RFI) and electrostatic discharges (ESD).

For example, in one of our internal fundamental research projects we are building a simulation framework for comparing the EMI effects on analog building blocks e.g. current mirror structures or operational amplifiers. This tool, that is directly attached to the conventional Cadence Design System and Spectre simulation environment, extends the standard analog simulation by specific, newly developed Python® scripts for performing post-processing steps to analyze the circuits with respect to their EMI robustness. It also highlights e.g. the distribution path of the interfering signal within the circuitry as well as certain building blocks which are influenced by the interference and thereby helps the designer to identify EMI problems already during the design an concept phase [2-4].

Radiation Hardness

Ionizing radiation is one of the important environmental factors that strongly influence the operation of integrated circuits. Specifically a prolonged exposure to radiation induces defects in transistors, meaning change of electrical characteristics as well as increased noise. Since exposure to ionizing radiation has consequences on the device and circuit reliability, it has to be particularly considered for applications in space, medical diagnostics and in accelerator electronics. Next to environmental tests to evaluate device robustness to radiation, often additional measures to mitigate the effects have to be implemented [5].

The projects at the IFE over the recent years cover this range of critical applications. The research team has gained experience in performing stress tests and ionizing dose calibration. Device characterization, defect evolution analysis and mitigation strategies to extend the lifetime are strong research focuses at IFE, where technology nodes from 180 nm down to 28 nm CMOS are covered.

Integrated Circuit Design

In the field of integrated circuit design (analog and mixed signal), 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 [6].

Mixed-Signal Design for Space Applications

For several years the IFE has been active in the area of developing high-precision microelectronics for space applications. In the field of mixed signal design, the focus lies on robust, radiation-hard chip design. This know-how is manifested in our research projects that have been carried out in close cooperation with the Space Research Institute (Austrian Academy of Sciences). Currently the IFE is working on the development and test of a new generation magnetometer front-end ASIC, based on a concept study, which was done within a precursor project [7]. The final goal is the space demonstration of the new ASIC aboard a Finish CubeSat mission called FORESAIL which shall enable a rapid technology verification.

Energy Harvesting

During the last decade, three PhD theses at the IFE have dealt with the topic of energy harvesting. In all of them test chips in modern CMOS production processes were designed and fabricated. The topics included on-chip power generation with solar cells, power management circuits with charge pumps and inductive DC/DC converters for ultra-low power and voltage and an ultra-low voltage digital cell library.

Besides photovoltaic, the main focus is on thermoelectric energy harvesting with thermoelectric generators (TEGs = Peltiers). Based on the test chip developments, an industrial partner (Matrix Industries) designed two product chips for very low unipolar (Mercury) and bipolar (Mercury2) input voltages which are both best in class for start-up power and efficiency. Mercury is mainly used for devices which are powered by body heat while Mercury2 can be used in applications where the output voltage of the TEG changes polarity and also for small AC input voltages from electromechanical generators [8].

ESD and Transient Disturbances

An electrostatic discharge (ESD) can cause malfunction and even permanently damage an electronic system. Shrinking devices made ESD protection almost mandatory. The know-how on how to design this ESD protection is a hard-earned currency by years of trial and error. To get insight on how to protect a device, a suitable characterization methodology has to be established.

The IFE researches on such a characterization methodology based on Transmission Line Pulsing (TLP). The device under test is stressed with a TLP setup while relevant parameters of the device are recorded. This gives information on how a device responds to TLP. Depending on the demands on the device under test, failure criteria can be defined for the recorded parameters [9]. This allows to pick the most robust and suitable device for a given system. To get insight on how to protect a device against damage und disturbance, a simulation strategy has to be established. This requires the characterization and modeling of ICs and protection devices. Data from a Transmission Line Pulser (TLP) characterization that describes the reaction to high current/high voltage is combined with electromagnetic models to predict the protection level and to optimize it. This also includes disturbances which occur at levels below damage. Typical target platforms are the RF front ends of mobile devices and high speed interconnect such as USB 4.x.

EMC Simulation

For some years now there has been growing interest in making simulations in the field of electromagnetic compatibility (EMC). Even before building a first prototype, manufacturers want to know how susceptible their product is to external interference. But there is also a great deal of interest in estimating the interference caused by the device itself. This makes it easier to estimate which filter structures are necessary in the worst case to obtain CE certification for the finished product.

For several years, the IFE has therefore been conducting research in joint projects with industrial partners to create simulation models for components, measurement devices and measurement setups that are important for EMC simulation [10]. With these simulation tools it should one day be possible to predict not only the general electromagnetic compatibility but also the effects of aging and temperature influences on the EMC behavior of devices in advance.

Important Publications

[1] **Deutschmann, B, Kastner, P, Winkler, G "Fault state behavior of smart power devices during electromagnetic interference,"** 2018 IEEE International Symposium on Electromagnetic Compatibility and 2018 IEEE Asia-Pacific Symposium on Electromagnetic Compatibility, pp. 44-49, 2018. https://doi.org/10.1109/ISEMC.2018.8394033

[2] **Zupan, D, Deutschmann, B "Comparison of EMI Improved Differential Input Pair Structures Within an Integrated Folded Cascode Operational Transconductance Amplifier,"** Proceedings – 2020 Austrochip Workshop on Microelectronics, Austrochip, pp. 47-52, 2020. https://doi.org/10.1109/Austrochip51129.2020.9232994

[3] **Zupan, D, Deutschmann, B, "Comparison of EMI Effects on Different Current Mirror Structures using a Post-processing Framework,"** Journal e&i Elektrotechnik und Informationstechnik. 137(2), pp. 93–99, 2020. https://doi.org/10.1007/s00502-020-00786-w

[4] **Zupan, D, Deutschmann, B, "Identification of EMI Induced Changes during the Design of ICs using a Post-Processing Framework,"** SMACD 2019 - 16th International Conference on Synthesis, Modeling, Analysis and Simulation Methods and Applications to Circuit Design, Proceedings, pp. 201–204, 2019. https://doi.org/10.1109/SMACD.2019.8795218

[5] **Bezhenova, V., Michalowska-Forsyth, A., "Aspect ratio of radiation-hardened MOS transistors,"** Journal e&i Elektrotechnik und Informationstechnik, 135, pp. 61–68, 2018. https://doi.org/10.1007/s00502-017-0575-2

[6] **Auer, M & Karaca, TD 2019, "A Class-D Amplifier with Digital PWM and Digital Loop-Filter using a Mixed-Signal Feedback Loop,"** in ESSCIRC 2019 - IEEE 45th European Solid State Circuits Conference (ESSCIRC) & 49th European Solid-State Circuits Conference, pp. 153–156, 23/09/19. https://doi.org/10.1109/ESSCIRC.2019.8902785

[7] **Scherzer, M, Auer, M, Valvanoglou, A, Leitner, S & Magnes, W, "Circuit Design and Verification Method of Integrated Sensor-Front-End Elements for Spaceborne Fluxgate Magnetometers,"** in 15th Conference on Ph.D Research in Microelectronics and Electronics (PRIME), Lausanne, Switzerland, 15/07/19. https://doi.org/10.1109/PRIME.2019.8787744

[8] **Dillersberger, H, Deutschmann, B & Tham, D, "A bipolar ±13 mV self-starting and 85% peak efficiency DC/DC converter for thermoelectric energy harvesting",** Energies, vol. 13, no. 20, 5501, 20/10/20. https://doi.org/10.3390/en13205501

[9] **Schrey, P, "Soft-Failures in Component-Level ESD Testing on the Example of a Bandgap,"** in 2019 12th International Workshop on the Electromagnetic Compatibility of Integrated Circuits (EMC Compo), Haining, China, 21/10/19. https://doi.org/10.1109/EMCCompo.2019.8919921

[10] **Fuchs, M, Spielberger, L, Odreitz, K & Deutschmann, B, "Fast and simple model generation for superjunction power MOSFETs: An easy way to get accurate SPICE models even without precise information from the data sheet"**, e&i - Elektrotechnik und Informationstechnik, 2020. https://doi.org/10.1007/s00502-020-00860-3

[11] **Pak, S, Mousavi, M, Pommerenke, D, Maghlakelidze, G and Xu, Y "Improvement of SPICE based ESD Protection Models for I/O Protection Modeling,"** 2021 IEEE International Joint EMC/SI/PI and EMC Europe Symposium, 2021, pp. 1006–1011, doi: 10.1109/EMC/SI/PI/EMCEurope52599.2021.9559224.

[12] **Maghlakelidze, G, Shen, L, Gossner, H, Pommerenke, D and Kim, D "IC Pin Modeling and Mitigation of ESD-Induced Soft Failures,"** in IEEE Transactions on Electromagnetic Compatibility, vol. 63, no. 2, pp. 375–383, April 2021, doi: 10.1109/TEMC.2020.3011544.

Link to all publications

Microelectronics

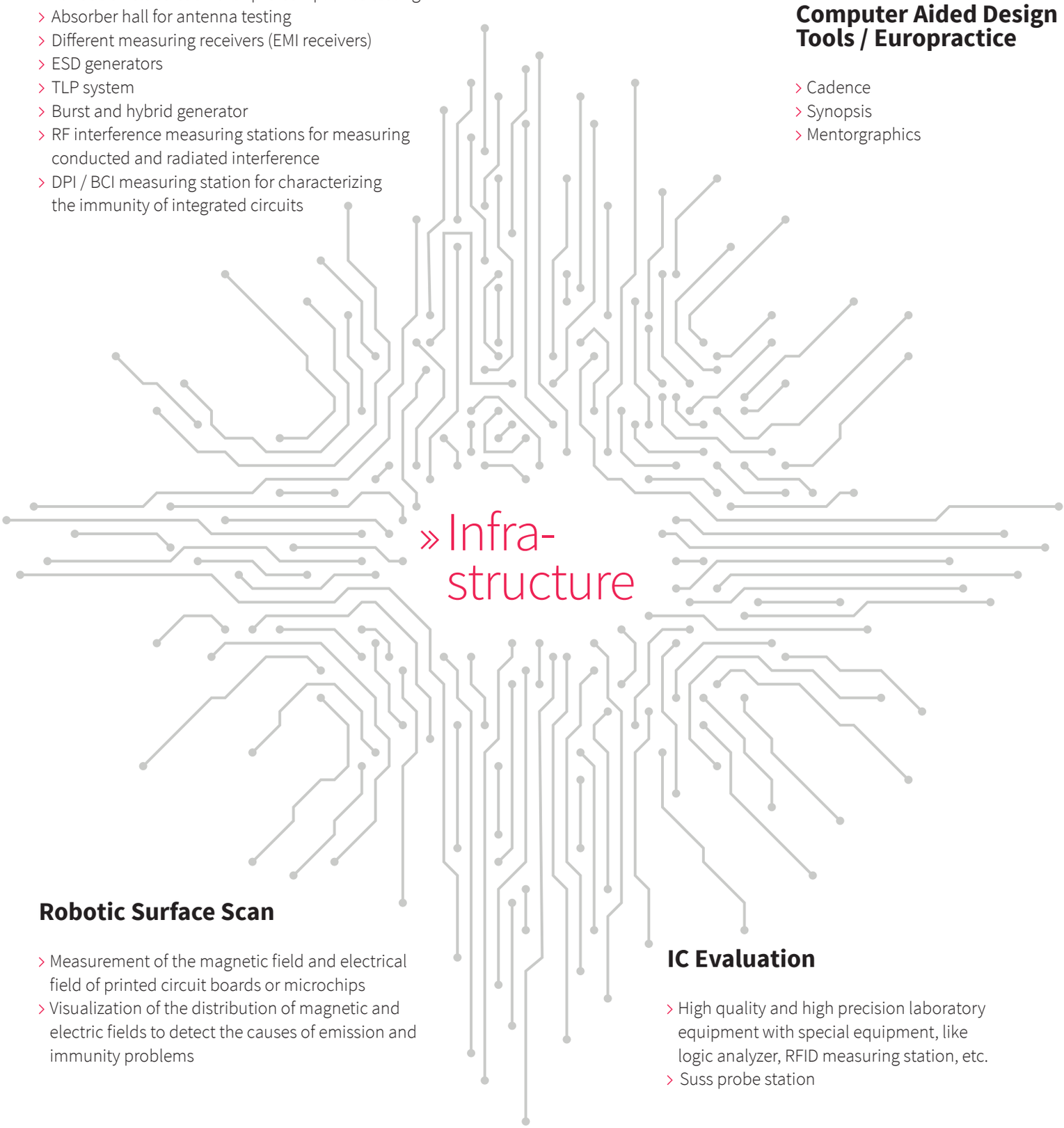
- 4 passive probe holders
- Laser cutter
- Wire bonder

Interference Emission and Immunity Measurements

- Various shielded cabins for pre-compliance testing
- Absorber hall for antenna testing
- Different measuring receivers (EMI receivers)
- ESD generators
- TLP system
- Burst and hybrid generator
- RF interference measuring stations for measuring conducted and radiated interference
- DPI / BCI measuring station for characterizing the immunity of integrated circuits

Computer Aided Design Tools / Europractice

- Cadence
- Synopsis
- Mentorgraphics



» Infra-structure

Robotic Surface Scan

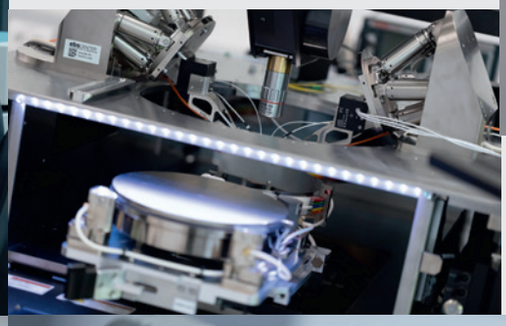
- Measurement of the magnetic field and electrical field of printed circuit boards or microchips
- Visualization of the distribution of magnetic and electric fields to detect the causes of emission and immunity problems

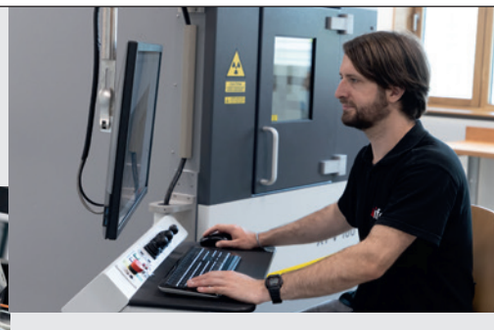
IC Evaluation

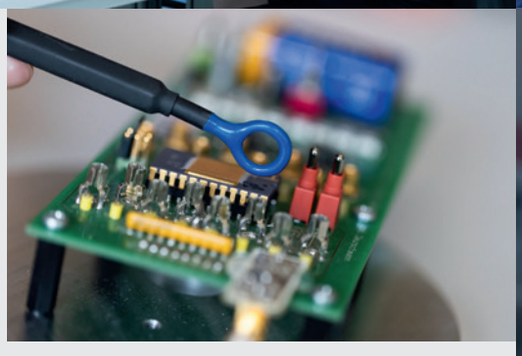
- High quality and high precision laboratory equipment with special equipment, like logic analyzer, RFID measuring station, etc.
- Suss probe station

Fast Prototyping

- 3D printer
- 2-layer milled PCBs







» Our Partners

Industrial Cooperation

As part of the EMC research at the IFE we closely cooperate with leading companies. Most research includes characterization of devices, such as integrated circuits for robustness and unwanted emissions, modeling in circuit and electromagnetic level and optimizing protection design or minimizing unwanted emissions.

Cooperations with Nexperia, Google and NXP cover the protection of circuits against electrostatic discharges mainly for mobile devices. In partnership with Juniper Networks, ESDEMC, MST EMC lab and Cisco we are creating a reference design and system for the characterization of the unwanted electromagnetic emissions of electrical/optical modules which are used in the back-bone of the Ethernet. The analysis, modeling and suppression of electromagnetic near fields, which may create unwanted radiating structures, is investigated with ASUS and API. The robustness of consumer grade highly complex integrated circuits for the usage in much more demanding environments in industry and automobile is a core goal of our research with Intel, TU-Muenchen and Fraunhofer.

The cooperation is setup such that core results will lead to publications, mainly in the IEEE Transactions on Electromagnetic Compatibility. Some projects are open hard- and software.

Silicon Austria Labs

In early 2020, TU Graz and Silicon Austria Labs (SAL) launched the GEMC Lab (Graz Electromagnetic Compatibility Lab), laying the foundation for joint basic research in the field of electromagnetic compatibility (EMC) of electronics-based systems (EBS). Modern electronic systems often contain a large number of integrated circuits with millions of transistors, highly complex printed circuit boards and a wealth of passive components. The undisturbed interaction of all these components significantly determines the performance and reliability of the entire system. Therefore, it is very important to be able to make appropriate predictions about the electromagnetic emission and immunity against interferences already during the development phase in order to ensure the coexistence and compatibility of the overall system.

Teams from the Institute of Microwave and Photonic Engineering (IHF), Institute of Fundamentals and Theory in Electrical Engineering (IGTE), Institute of Electronics (IFE) of TU Graz and SAL will conduct fundamental research to find out how such systems can be designed to function properly in their electromagnetic environment. The research objectives include the creation of EMC simulation models for components and subsystems, the development of new simulation tools, and the reduction of the complexity of EMC simulation models with the aim of being able to estimate the EMC behavior of the overall system in advance.

The mission:
“Our goal is to establish the GEMC Lab as the most scientifically recognized research lab for EMC-aware design and simulation of future EBS.”

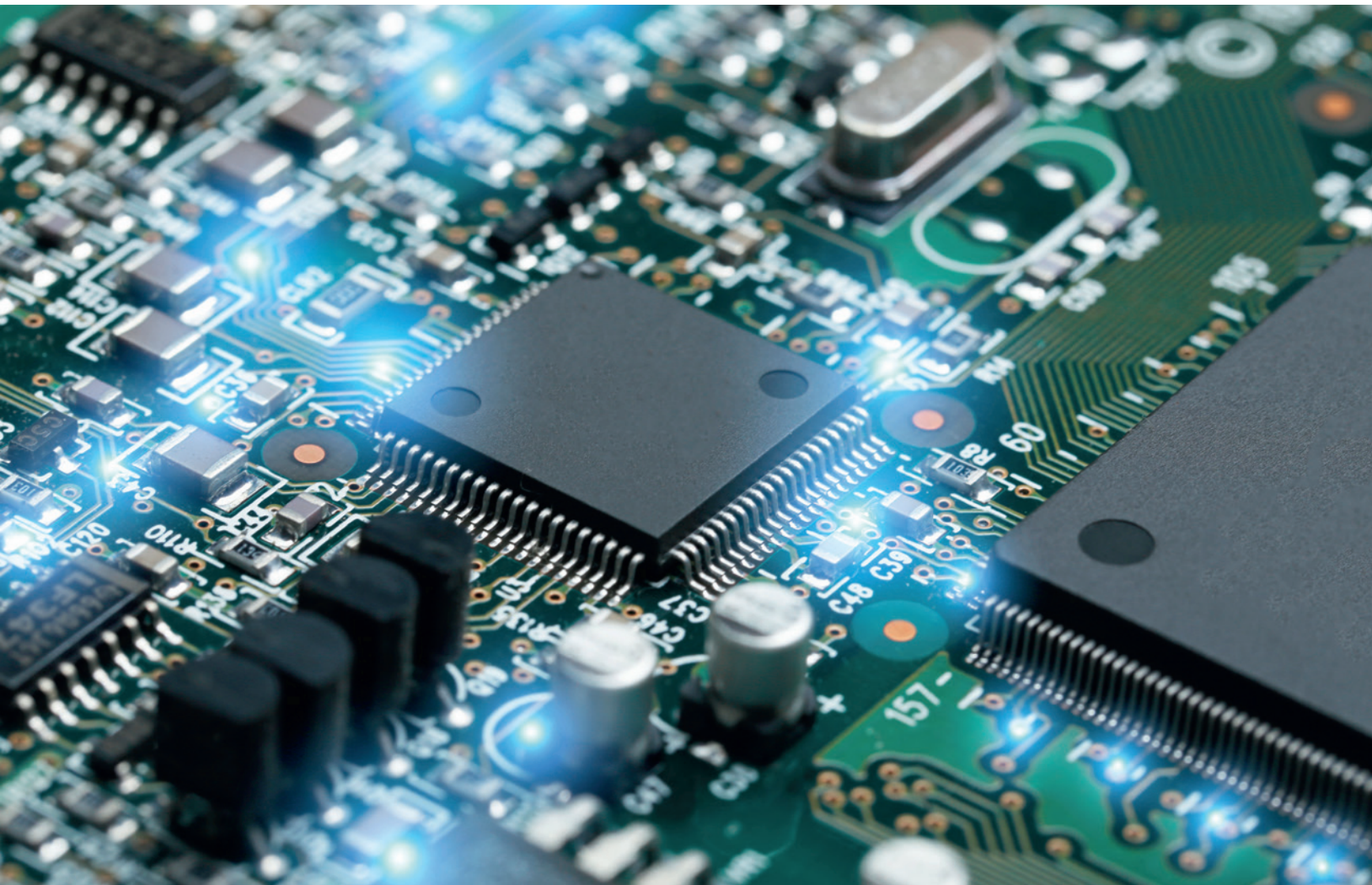
CAD Support for IC-Design

The Institute of Electronics has different supporters in the field of CAD tools for the development of integrated circuits. Most of them are provided in the EUROPRACTICE framework which is hosted by the Rutherford Appleton Laboratory since many years. The CAD tools offered there are industry standard but restricted for teaching purposes only. So, no commercial use is included in these licenses. The Institute of Electronics uses software from three companies: Cadence, Mentor Graphics (now part of SIEMENS) and Synopsys.

Apart from EUROPRACTICE, the Institute of Electronics is in the Cadence Academic Network (CAN) which was launched in 2007 by Cadence EMEA. The aim was to promote the proliferation of leading-edge technologies and methodologies at universities renowned for their engineering and design excellence. A knowledge network among selected universities, research institutes, industry advisors and Cadence was established to facilitate the sharing of technology expertise in the areas of verification, design and implementation of microelectronic systems. The CAN, therefore, significantly supports and improves the university activities. The Academic Network became an integral part of CDNLive! where universities and industry members are offered a knowledge exchange platform in oder to demonstrate scientific achievements, present ideas and establish further collaborations.

The High School Education Program (HEP) provided by SIEMENS EDA (former Mentor Graphics) gives high end CAD-Tools in the field of IC-Design and verification. The Synopsys tools are used in the fields of physically based device-simulation and circuit simulation (SPICE).

In general, a mix of different tools is used in the design flow of IC development.



» Conferences and Events

Microelectronics, Austrochip

Microelectronic activities at the Institute of Electronics (IFE) started in the mid 1980ies. Financial support came from the Austrian government and also from the local Styrian authorities. One way to document the status and the progress made in the field of microelectronics was the organization of a workshop (finally called Austrochip). Since the first workshop in 1991, the IFE was part of the Austrochip, and members of the IFE are represented in the steering committee from the beginning.

Austrochip is an annual meeting and platform to present the latest activities in the field of microelectronics and integrated circuits in Austria and neighbouring countries. The workshop is a forum for discussion and contact between academia and industry.

The 28th edition “Austrochip 2020” will take place in Vienna and is planned for the first time in an online mode.

Austrochip deals with the design of analog, digital, and mixed-signal integrated circuits and systems. The following topics are in the scope:

- Analog, mixed-signal, and RF integrated circuits
- Digital circuits, filters, DSPs, asynchronous designs
- FPGA design and reconfigurable hardware
- Design methodology, system-level design, giga-scale circuits, network-on-chip
- Embedded systems, low-power designs, RF systems, security aspects
- Verification and testing, signal integrity, device modeling, timing analysis, reliability simulation
- Emerging technologies, nano CMOS process, sub-threshold circuits, sensors, organic and biomedical electronics
- Case studies and prototyping

IFE has organized this workshop five times so far.

EMV Fachtagung (EMC Symposium)

The EMC symposium is the most scientifically interesting EMC event in the Austrian EMC community. Due to many years of expertise, the EMC symposium has become an annual fixture. The EMC experts from science and industry present the latest technical results from research and development as well as practice-relevant EMC knowledge. Highlights include technical lectures, workshops, tutorials, community contacts and the extensive product exhibition.

Silicon Valley Austria

If any industry can claim to have permanently changed our world and our everyday lives in recent decades, it is the microelectronics industry. It is remarkable how the microelectronics industry has developed since Jack S. Kilby invented the microchip sixty years ago.

Can you imagine a world without microelectronics today? Microchips today can comprise circuits with many billions of electronic components – especially transistors. Modern microchips, such as Huawei's Kirin 990 5G, have up to 10 billion transistors integrated. That's more transistors in a microchip the size of a fingernail than there are people on the planet. Highly complex microprocessors and memory chips are housed on just a few square millimeters and are largely manufactured in state-of-the-art smart factories in Asia or the USA, for example.

However, hardly anyone knows that numerous microchips are also being developed and manufactured here in Austria, for example for applications in motor vehicles, smartphones, for contactless payment using cash cards or for electronic passports.

In Austria, there are about 200 companies at just as many locations with around 60,000 people employed in the electronics based systems industry. In the Graz area in particular, there is a unique cluster of semiconductor companies – the so-called "Silicon Valley" of Austria. We are very proud to have all these companies here in Austria and to have a good cooperation with them in numerous research projects for years. Many of our students also take advantage of the opportunity to gain initial work experience with these companies during their studies.

» Teaching

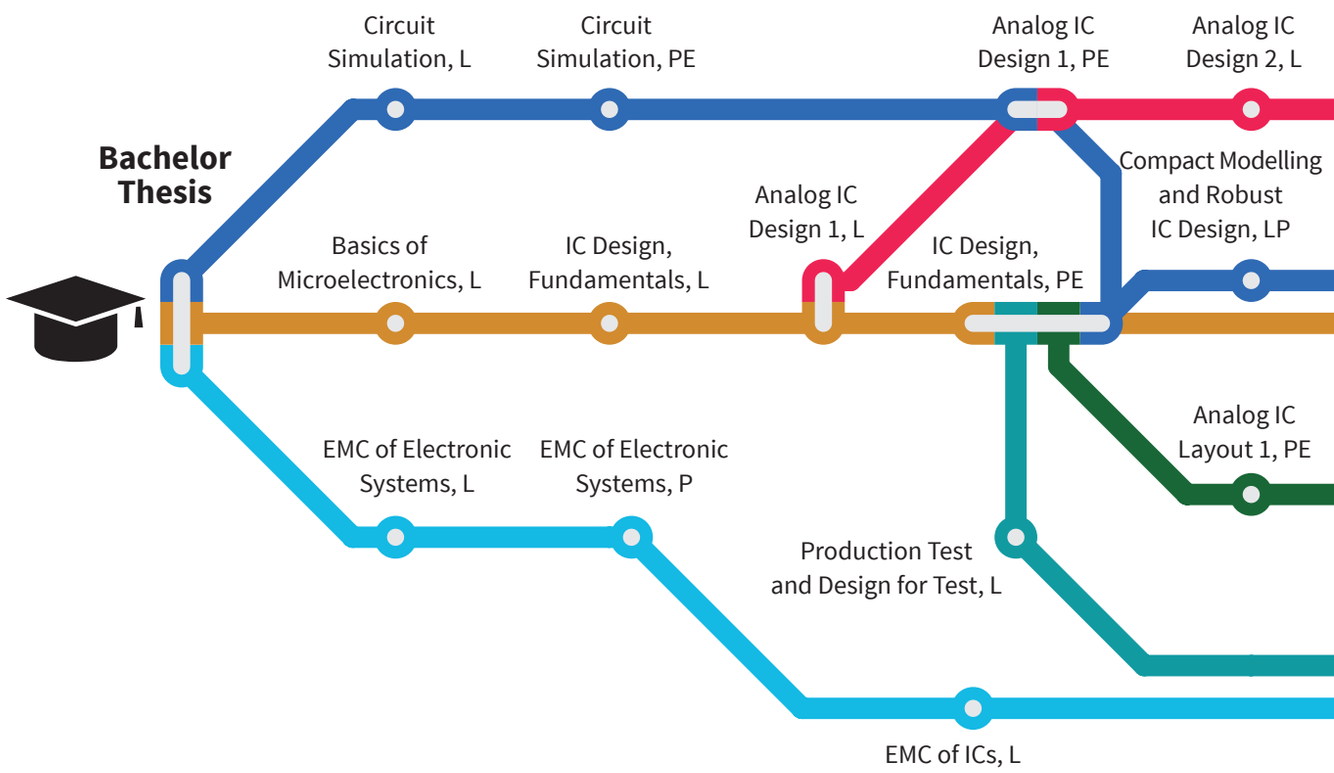
The IFE combines modern courses in microelectronics and EMC research with state-of-the-art didactics and teaching materials. The IFE established a master program called “Analog Chip Design”"" several years ago. A broad variety of courses had been set up to provide students with the possibility to acquire the required fundamentals for the challenging field of analog integrated circuit design.

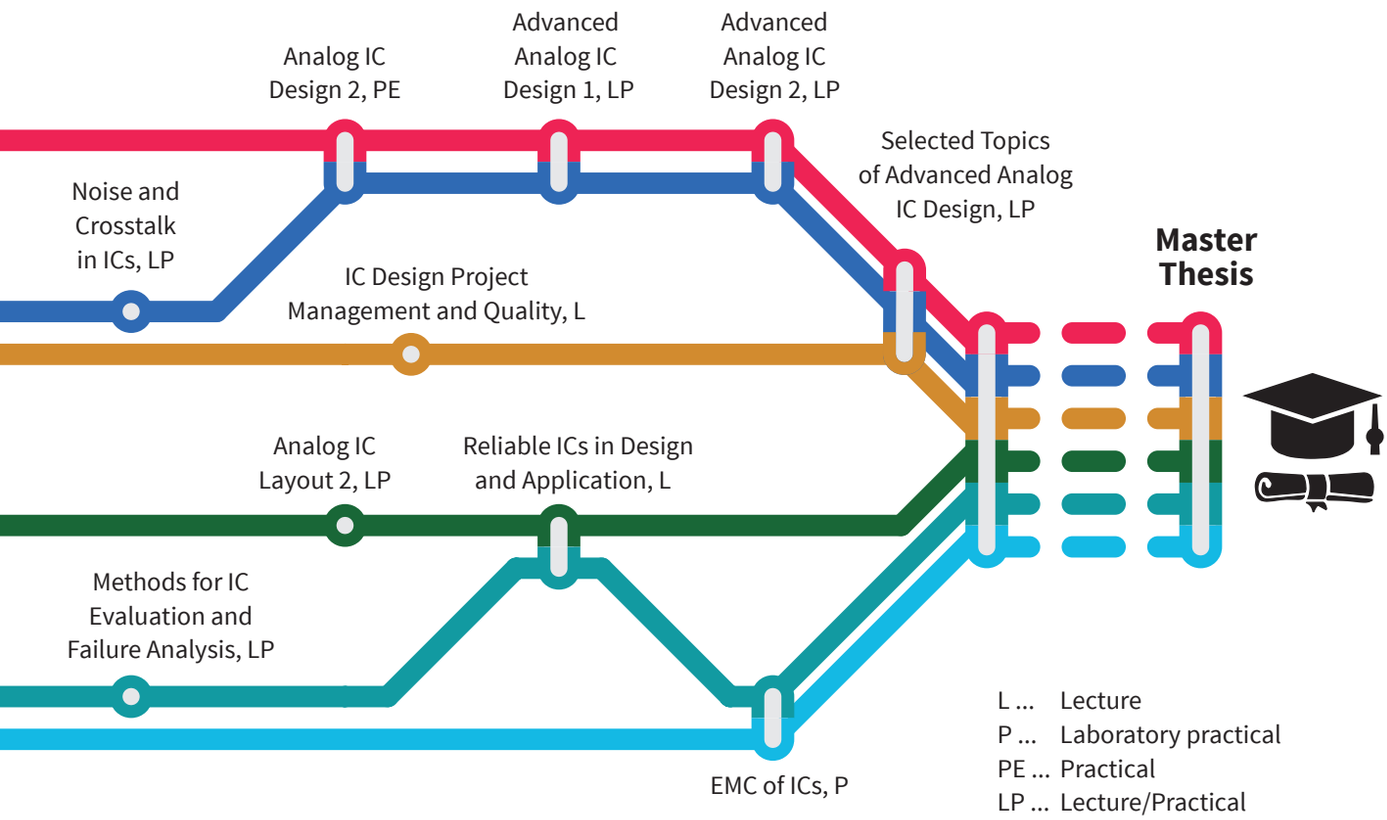
Analog Chip Design

The “Analog Chip Design” program is a master program with a duration of four semesters and containing numerous courses that build on each other aiming at a solid education in the challenging field of transistor level circuit design ranging from elementary stages to complex building blocks complemented by courses that allow further specialization.

A number of microelectronics companies are located in Graz, offering many opportunities in the field of research and development of analog circuits, giving the students an interesting perspective for their career. We are also proud to be part of the Cadence Academic Network to facilitate the sharing of technology expertise in the areas of verification, design and implementation of microelectronic systems.

The different paths to your master's degree




Analog IC
Design 2, PE
Advanced
Analog IC
Design 1, LP
Advanced
Analog IC
Design 2, LP
Noise and
Crosstalk
in ICs, LP
Selected Topics
of Advanced Analog
IC Design, LP
Master
Thesis
IC Design Project
Management and Quality, L
Analog IC
Layout 2, LP
Reliable ICs in Design
and Application, L
Methods for IC
Evaluation and
Failure Analysis, LP
EMC of ICs, P
L ... Lecture
P ... Laboratory practical
PE ... Practical
LP ... Lecture/Practical

Didactics

For several years, the IFE has been one of the leading institutes in the field of digital teaching at TU Graz. We have produced a lot of open educational resources and are involved in various teaching projects for the education of our students and in the area of the 3rd mission of the TU Graz for further training in the industry. Many projects like Inno EBS, METIS or TEL Marketplace are proof of our success.

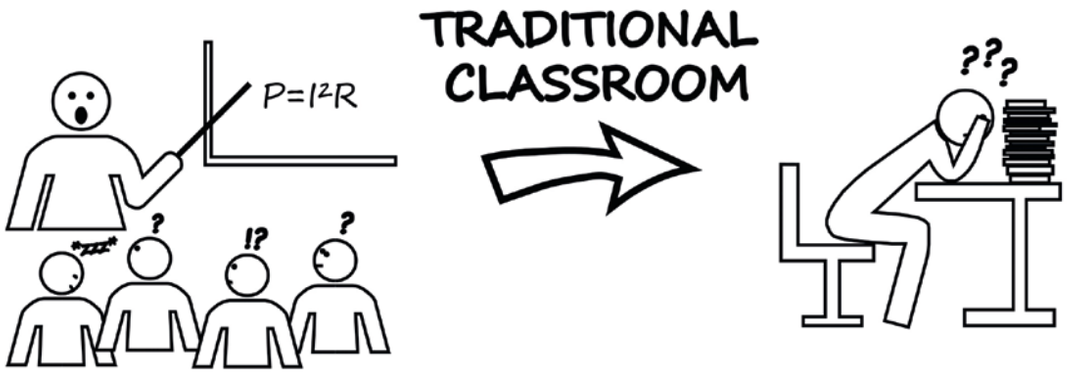
For our efforts in the field of digital teaching, the IFE received the ”Award for Excellent Teaching“ by TU Graz in 2020 for the course “Electronic Circuit Design 2“.

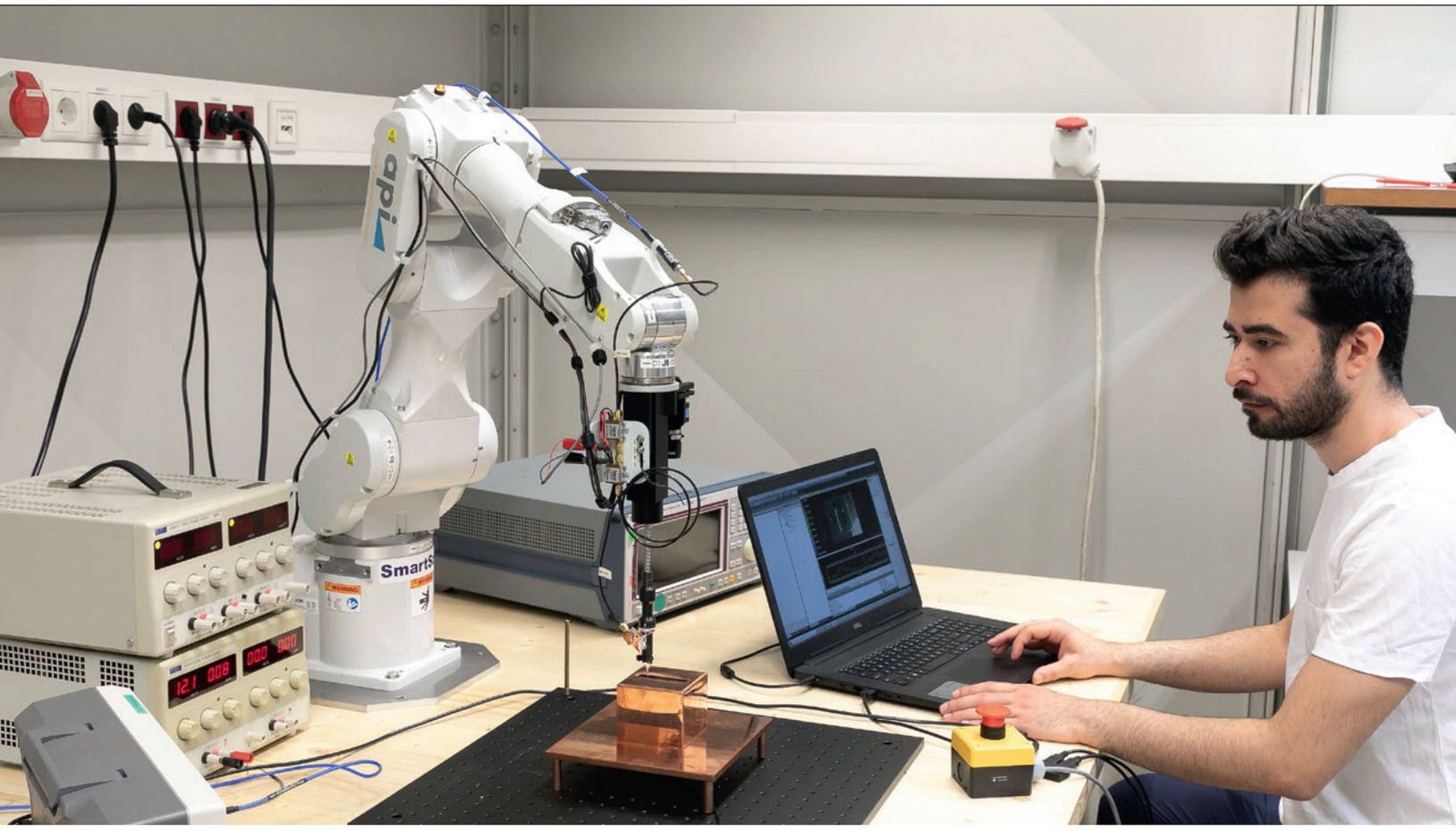
Video Tutorials

Since 2018, IFE has been producing publicly accessible educational videos in the field of electronics together with the organizational unit Educational Technology and iMoox at TU Graz. All videos are Open Educational Resources (OER) and are CC-BY licensed.

Flipped Classroom

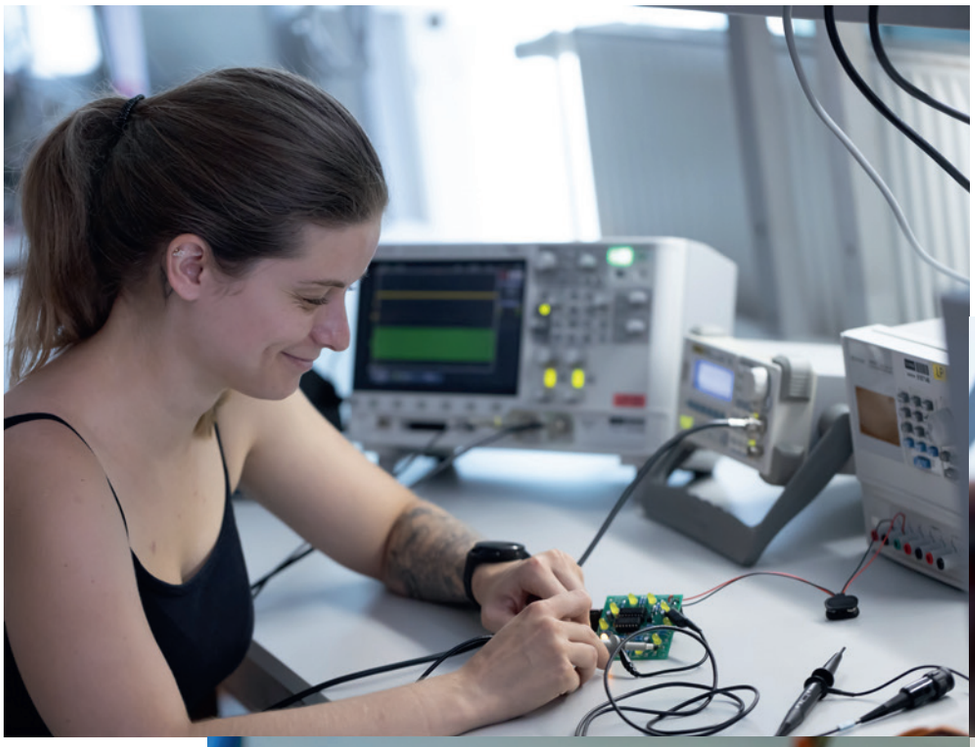
“Flipped Classroom” is one of the most modern didactic methods we use. Behind this expression is the idea of using the time in the lecture hall as productively as possible. To this end, course participants are confronted with the content of the course in advance with the help of short videos or other digital documents. Armed with prior knowledge, the lecture time can be used to deepen the content. We use this technique in basic courses on “Electronic Circuit Technology“, but also in projects such as Inno EBS and METIS.

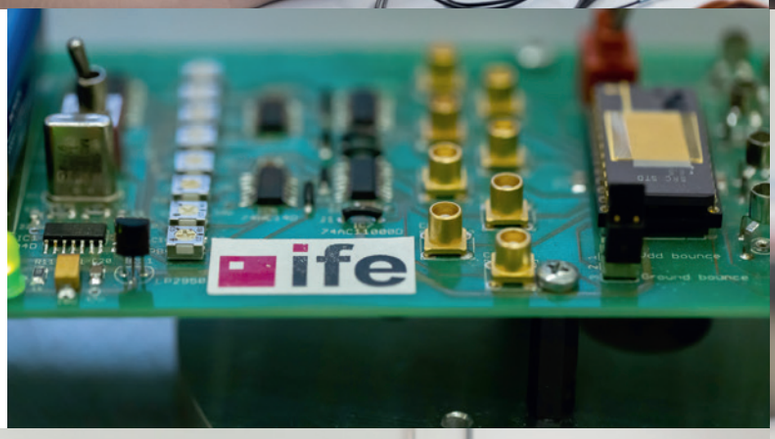




Infrastructure in the Teaching Environment of IFE

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 individual 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 IT backbone is based on a high speed network and a strong server infrastructure. High end measurement equipment is available, too, for use in advanced laboratory exercises (e.g. IC- and EMC-characterization).

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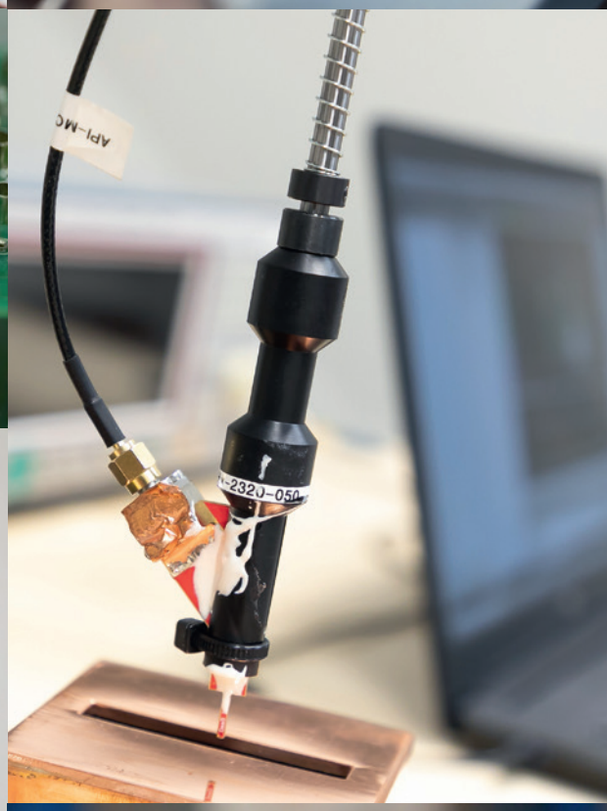
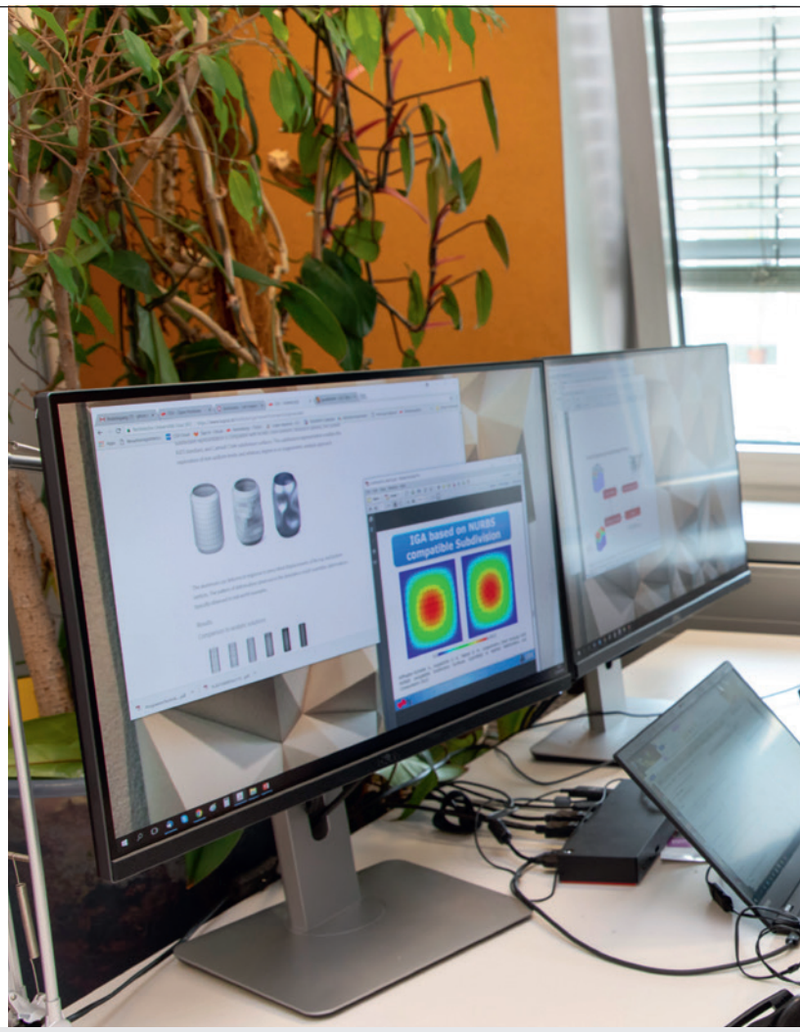


» Future

The microelectronics and electronics-based systems industry offers a wide variety of employment opportunities. On a regional level, there are a number of companies active in the field of microelectronics, particularly in Styria and Carinthia, which form Austria's Silicon Valley. Many of these companies are active on a national as well as on a European and international level. Thus, the skills you will learn at our institute can be applied in most parts of the world.

There is a shortage of skilled Information and Communication Technology (ICT) graduates in Europe, and a growing skills gap and supply/demand mismatch, particularly in the microelectronics industry. Our Institute is therefore working with its industrial partners to overcome this skills mismatch. Due to high demand and low supply in the EBS sector, Europe is gradually losing people with the qualifications and skills needed for the electronics ecosystem, especially for Industry 4.0, Artificial Intelligence and Big Data.

Graduates in ICT and Electrical Engineering can therefore choose from a variety of jobs in both the academic and industrial sectors.



Academic Jobs

If you want to start your career in academia, there are generally two different paths you can take:

University Assistant
As a University Assistant one is involved in both teaching and research.

As a teacher, your role is not only to give lectures, exercises and experiments, but also to supervise and assist students with their bachelor and master theses and other projects. Adapting to students' needs and experimenting with new and different teaching methods and concepts is key to successfully educating as many students as possible, which is why the university offers a number of specialized training courses.

» As a researcher, your role is to focus on a specialized, scientifically unexplored topic of interest to yourself or your supervisor. Typically, you will also write a PhD thesis during your research activities. Your main activities during your research will be to present your new findings at conferences, in journal papers and posters, and to attend international conferences to interact with communities related to your topic.

University Project Assistant
Project University Assistants are fully employed to carry out research, mainly within the context of a pre-determined project. Teaching can be done on a voluntary basis, e.g. presenting new research topics in advanced Master's lectures.

In both career paths, you can work towards your PhD. Further along this path, you can become an assistant professor, associate professor or university professor.

Jobs in the Industry

If you want to start your career in industry, there are many more jobs to explore. Some of the most requested job profiles are listed below.

- Design engineer:
  - System design engineer,
  - Analog design engineer,
  - Digital design engineer,
- Process engineer
- Test engineer
- Applications engineer
- Manager or Director
- Lead, supervisor
- Marketing engineer
- Material engineer
- Hardware engineer
- Software engineer
- RF engineer
- Power electronics engineer
- Maintenance engineer
- Robotic engineer
- Data scientist
- Operator, Inspector

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