gan-on-Silicon Efficient mm-wave euRopean systEm iNtegration plAtform

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Consortium
9 partners (5 countries)

Project Coordinator
Dr. Klaus-Michael KOCH
coordination@serena-h2020.eu

Technical Leader
Dr. Kristoffer Andersson
kristoffer.andersson@ericsson.com

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EC contribution: **EUR 3,910,185**

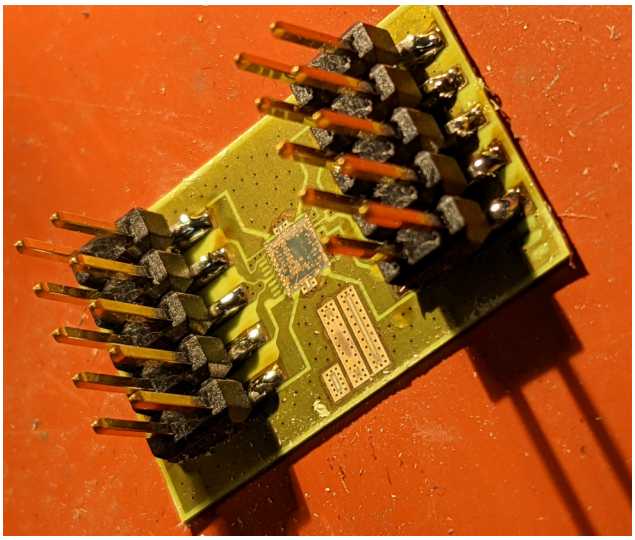
Message from the Coordinator

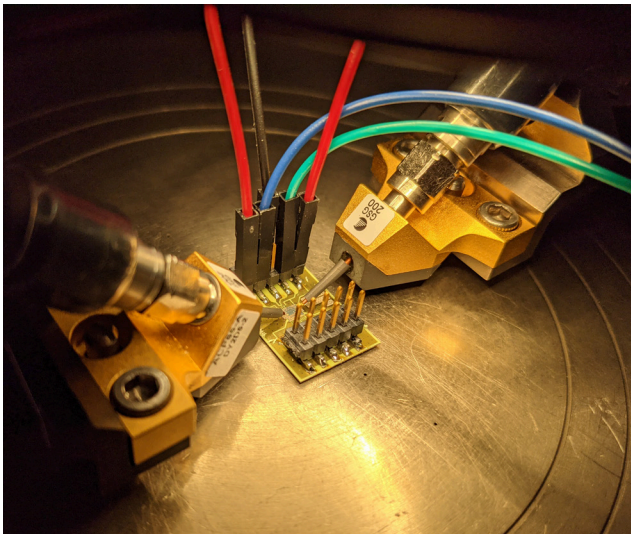
The SERENA project was launched almost four years ago to develop a system architecture and technology platform by using an integrated approach.

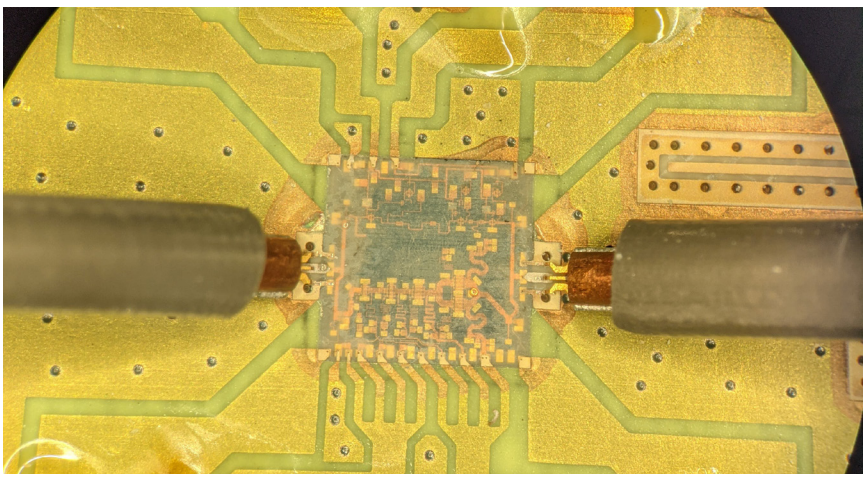
Over the years nine partners from five different European countries collaborated to foster an inter-disciplinary design approach with a strong emphasis on multi-physics simulation and predictive co-design.

Embedding of GaN-on-Si MMIC in PCB

One of the major challenges in the SERENA project is the embedding of power amplifiers from GaN-on-Si technology. The main challenges involving the embedding of such GaN-on-Si mmIC arise from the presence of air bridges and thin pad metallization of the mmIC. The embedding of GaN-on-Si amplifier mmIC was successfully accomplished by Fraunhofer IZM by fine tuning of each process steps in the embedding process. The critical parameters optimized to achieve this goal of embedding includes, pressure applied at each step of embedding process, type of sinter gluing technique used and time of exposure of laser for microvia. RF measurement of amplifier ICs were performed after each individual critical process step to validate the reliability of the embedding process after corresponding process step. Successful fabrication and RF measurements of the embedding test module including Fan-out metallization was accomplished at Fraunhofer IZM.

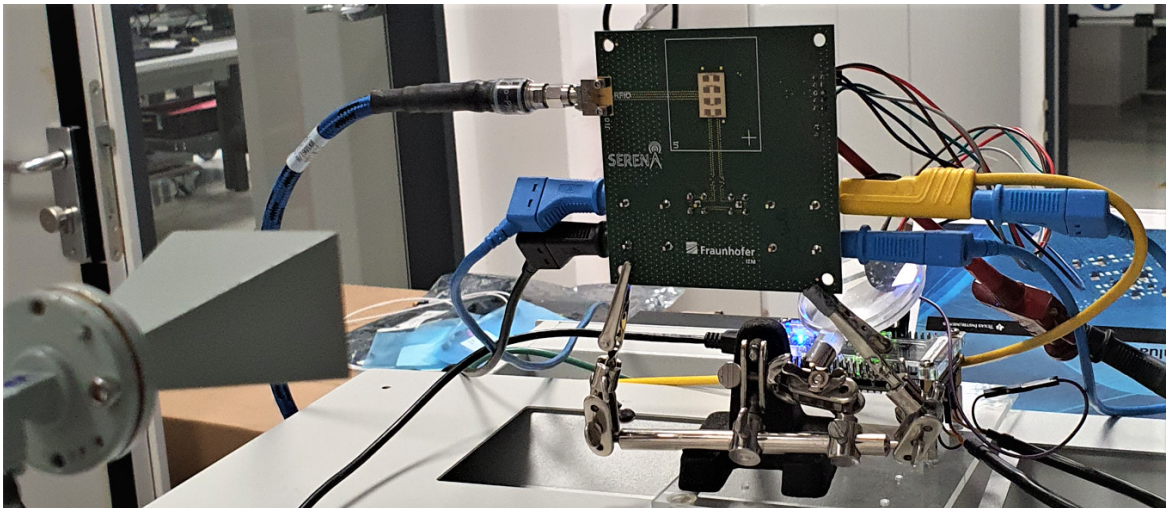






Embedding of SiGe RFIC in PCB and calibration

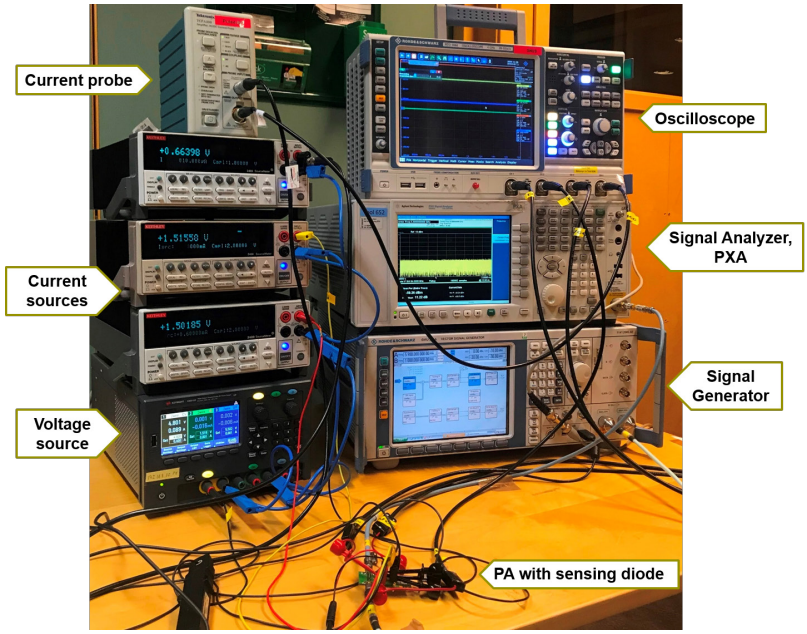
One of the core innovations of the SERENA project is the antenna-in-package packaging and the embedding of the beamforming integrated circuit. Fraunhofer IZM has achieved this goal and successfully manufactured an integrated module with the embedded Infineon beamformer and a two-by-four antenna array. This module is the core component of the envisioned SERENA system. TUB and Fraunhofer IZM have worked together during the last weeks to take the module into operation. Fraunhofer IZM has set up a test board with a single integrated module. One crucial step for beamforming systems is the calibration of the beamforming and the antenna elements. TUB has developed a calibration system for the SERENA module. Together with the Fraunhofer IZM, TUB has run measurements with the test board and successfully calibrated the integrated module.



Multiphysics co-simulation

As part of the project, Chalmers has developed a highly efficient multi-physical methodology for the SERENA module to accurately model and characterize the mmWave active antenna array performance. The proposed method can combine different physical behavior of many sub-systems such as thermal, electrical, and electromagnetic radiation of active circuits and antenna arrays, embedded in the module. This method can predict the emitted signal, considering the interaction between different sub-systems described by different physics, no matter how many RF branches are included in the integrated module.

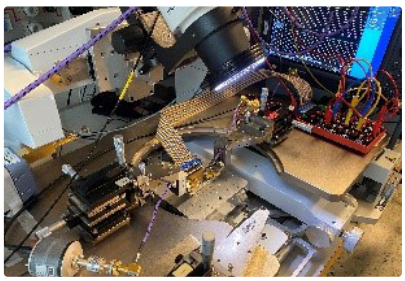
A measurement setup is developed to evaluate and verify the multi-physical behavior of the module. This setup simultaneously measures temperature and the effect of heat dissipation and temperature variation on the output signal. With this setup, various multi-physical verification tests can be performed, such as evaluating dynamic and static linearity, output power, and efficiency of the ultimate transmitted signal.



E/W-band GaN-on-Si multifunctional MMICs

The SERENA project has also addressed the realisation of GaN-on-Si multifunctional single-chip front-end MMICs for target applications such as E-band point-to-point communication links as well as W-band short-range radars. E/W-band front-ends with state-of-the-art performance typically contain one or several split-block waveguide modules that are more suitable for single-channel RF systems. GaN-on-Si multifunctional single-chip front-ends can enable more highly integrated multi-channel systems (active antenna arrays) at mm-wave frequencies where the package loss and cost are higher. Thus, a main target for the E/W-band GaN-on-Si single-chip transmitter/receiver MMICs developed in SERENA was to achieve a compact size (higher integration and lower cost) together with adequate RF performance. FOI and EAB have designed low-noise, high-linearity amplifiers and frequency up/down-converters which are used in some initial E/W-band GaN-on-Si single-chip transmitter and receiver front-ends.

The fabricated E/W-band GaN-on-Si amplifiers, mixers and single-chip front-ends have been characterised in terms of output power, linearity, noise figure and conversion gain.



SERENA Impact Video, Podcasts and thematic webinar series

The SERENA project has achieved real world communication solutions. At a time when 5G is in rapid growth mode, we were able to make meaningful contributions to the industry and the marketplace. As society evolves towards mobility, the demand for a super-fast and reliable infrastructure is loud and clear. Within the SERENA project we stepped up to provide new solutions while building a European community equipped to compete globally. In order to show this to our stakeholders and the civil society, we created an impact video, which is available on our project website.

In addition, we recorded a number of podcasts with project partners, talking about the goals and objectives of SERENA and how they contribute in particular. All podcasts can be accessed on our project website.

One of the highlights was the webinar series – **Results towards enabling technologies for future 5G mmWave base station systems** – the SERENA consortium organised in October and November 2021.

The series consisted of three one-hour thematic workshops:

- Workshop #1: Heterogeneous Integration for High Performance mmWave Electronics

- Workshop #2: GaN-on-Si for mm-wave applications

- Workshop #3: Multi-physical modelling for active antenna transmitter systems

The recorded webinars as well as the presentations are available on the project website.

Follow SERENA on:

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