Car2TERA

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Eyes and Ears for the Car of the Future

Terahertz sensors and networks for next generation smart automotive electronic systems

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Budget

€ 3.9 Million
100% EU-funded

Consortium

9 Partners
5 countries

Duration

48 Months
01/2019 - 12/2022

3rd Project year: A successful review and outlook for the final phase

Message from the Scientific and Technical Leader: Dr. Joachim Oberhammer (KTH)

The Car2TERA project team set themselves with the project the challenge to combine latest, cutting-edge technologies into a novel, very advanced frequency car radar sensor, as well as a terahertz-over-fiber communication system, both to be demonstrated at a relatively high technology readiness level (TRL) for such a project and considering the challenges faced. It is exciting to see how the project has already succeeded on so many levels producing exceptional results with significant impact and several world-first developments in terms of integrated MMIC circuits and integration. The integration of the results of the different partners move the project forward innovatively creating strong impacts the academic and industry communities.

We are now in the final year of the project and look very much forward to demonstrate this innovation through our prototypes in the two demonstrator tracks: (1) in-cabin car radar; (2) teraherz-over-fiber communication.

About

From Advanced Driver Assistance Systems (ADAS) to fully Automated Vehicles, Car2TERA combines the results of recent achievements in semiconductor, micro- and nanoelectronics scientific projects. Car2TERA emerging technology and innovation will take next generation cars to the next level.

In an effort to explain the fundamentals of Car2TERA, **a video** was designed which offers a quick glance into the objectives of the Project. This video was intended to be shared on social media to raise awareness of Car2TERA. Please have a look and share with colleagues who are interested in your work.

Project Status Update

WP2 - Multi-purpose, broadband, SiGe (600-GHz fMAX) circuits for THz sensor & communication applications [M01-M45] Herbert Zirath (Chalmers)

The fabrication of the B12 designs have been completed and ICs passed on by IFAT to CHALMERS. The fabricated circuits from the 2020 spring tapeout in B11 and B12 were characterized and results were analyzed in order to improve the performance of the circuits. The Measurements from the B11-tapeout showed a significantly improved performance for RX/TX multifunction chipsets. A final tapeout was completed by end of 2021.

WP3 - Emerging technologies for future THz car sensors and networks (high-risk/high-gain) [M01-M42] Wlodek Strupinski and Iwona Pasternak (Vigo)

A single graphene layer and bilayer were grown using CVD method (contrary to the common technique of Si sublimation). The SiC wafers coated with graphene was characterized using Hall method in van der Pauw geometry, Raman spectroscopy, Atomic Force Microscopy and delivered to Chalmers for processing. Some work on different graphene growth methods have been performed to obtain a qualitative analysis of graphene quality, technology difficulties, costs of production, repeatability, feasibility and the most important usefulness for THz applications. A single and bilayer of graphene grown on SiC of different polytype 4H and 6H) were used as the benchmarking for alternative graphene fabrication protocols.

Design of graphene MMIC has been completed and a back-end process for GFET MMIC was developed. Passive elements based on the new process was fabricated and measured. Even though, graphene on SiC exhibits high mobility, after deposition of gate dielectric the achieved mobility is limited to 2000-3000 cm2/Vs. Achieving higher mobility after process can decrease on resistance and enhances the CL. Preliminary works have been done on a balanced mixer MMIC based on developed back-end process. The design and fabrication of the static antenna array front end has been completed. The measurements showed excellent agreement with simulations. The first prototypes chips, containing the complete beam-sweeping/beam-switching circuit, but with the MEMS switches in fixated positions, where already delivered by KTH to the end-user Veoneer. Of the three investigated signal processing methods, computational imaging is the most promising candidate but also requires the largest computational resources, followed by neural networking. Deterministic signal processing approaches are not considered as feasible for multi-target scenarios. The main focus since Jan. 2021 is therefore on computational imaging.

WP4 - Interfaces and packaging of new technologies into electronic systems [M01-M42] Joachim Oberhammer (KTH)

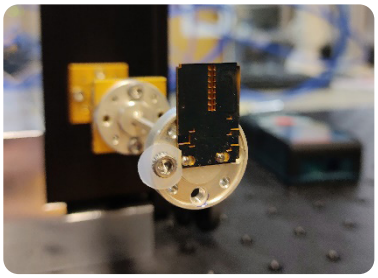
Work on the design of the micromachined radar front-end with integrated reconfigurability utilizing carefully designed and tested MEMS actuators was completed. The antenna and the radar chip with fixed switch states have been fabricated and measured - showing an excellent performance. In the final phase of the project a MEMS-reconfigurable beam-steering frontend is implemented, which allows for beam-shape switching and beam-steering over a wide field of view.

The project team further completed the designs for eWLB tests and the MMIC to micromachined waveguide transition designs on Infineon's B11HFC, B12 process and solutions using interposers of SiC, eWLB. The designs in the B12 process were sent for fabrication. Different design concepts for the interface of DEM 2 were investigated and a final design was chosen. Moreover, wire bonding transition from MMIC to PCB is being designed.

WP5 - Primary demonstrator: in-cabin car safety sensor for pre & post-crash passenger monitoring [M01-M48] Olof Eriksson and Hans Herbertsson (Veoneer)

For the primary demonstrator the test requirements, safety and health analysis, interface definition, use cases definition and verification plan definition has been completed. Proposals were provided for HMI design and implementation; on a reference system design and implementation, as well as data collection and evaluation system design and implementation proposal. The team also agreed on an Antenna design for the demonstrator and a test plan.

This has led to RCS testing of selected objects and humans at 240 GHz, using a rotating table capable of carrying objects of varying size and weight. Such measurements have been completed and documented. Work has also been conducted on the characterization of different fabrics and cloths wrt reflectivity and transparency. Currently, measurements using the KTH-fabricated antenna are made and the radar demonstrator build is about to begin.



WP6 - Secondary demonstrator: wide-band THz-over-plastic links for short range intra-base station interconnect [M10-M48] Yinggang Li (EAB)

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WP7 - Automotive System integration, System implications, Advanced processing & Sensor fusion [M01-M48] Olof Eriksson and Hans Herbertsson (Veoneer)

The team have completed simulations comparing the performance of different waveforms with respect to interference rejection and robustness. Performance tests on a radar simulator to confirm simulation results have also been completed, in both indoor test chambers and in real life outdoor environments and results have been analysed. Capabilities to improve detection performance for the antennas studied using AI have been tested with positive indications. Currently we are investigating the possible system improvement that can be achieved by fusing time synchronized data from multiple sensor sources. We consider radar + camera as well as multiple radars. Both vehicle internal and external applications are considered.

2nd Review Meeting

In January 2022 the Car2TERA project went through its second successful review as an extremely well managed project that continues demonstrating progress in the development of high bandwidth high frequency operation integrated sensor and communication systems. The excellent progress in the project meant not only were all deliverables accepted, but the reviewers also commended various aspects of the project. The exceptional results had already significant impact or already shine of further potential impact- The project team has a strong presence within the academic community from leading conference to a strong publication record. The industrial partners are clearly engaged in the work and have clear targets to exploit the technology.

The results in technological developments are impressive with several world first development in terms of integrated MMIC circuits and integration. The consortium also understands well some of the challenges remaining and the risks associated with the technological challenges, one example being the integrated MEMS technology. While the focus in application is clear and there is a strong understanding on key routes of exploitation, the technology that has already been demonstrated could already find application in other domains such as sensing. Regarding exploitation, the two main targets are THz enabled radar/in car sensing systems and wired communication system.

Technical Meeting, Milan, Italy

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Podcasts

The importance of communicating key themes of this exciting project was a passion of the project team. Five podcasts with Car2TERA team members who are leading researchers in their field guide us through the different challenges and opportunities the project worked on together to develop technology which are the eyes and ears of the car of the future.

E01

Consumer facing benefits bridging current gaps in autonomous driving

with Joachim Oberhammer (KTH)

E02

Importance of automotive radar to improve the knowledge of in-car monitoring

with Olof Eriksson (Veoneer)

E03

Development of high quality graphene that would satisfy the requirements of sub-THz devices

with Wlodek Strupinski (ENT)

E04

Discussion on increase in digital data processing, challenges of streaming the data and the opportunities of MIMO systems

with Jonas Hansryd & Yinggang Li (Ericsson)

E05

Car2TERA demonstrators and the importance of the signal processing circuits

with Herbert Zirath (Chalmers)

Consortium

The Car2TERA consortium consists of eight highly qualified industrial and academic partners from various backgrounds and five different countries (Austria, Sweden, Poland, Italy and Spain), making it well positioned to achieve its objectives.

Eight H2020 projects funded under call ICT-09-2017 form the Beyond5G Cluster, which aim is to offer a response to new challenges of future networks with above state of the art technologies covering all the major communication area from Gb/s to Tb/s. Car2TERA is proud to be part of this international initiative starting from 2020.

Related Projects

Past Events

International Microwave Symposium (IMS)
June 19-24
@Denver (US)

First Swedish Radar Workshop
May 31
@Linköping (Sweden)

18th European Radar Conference (EuRAD 2021)
April, 5-8
@London (UK)

European Microwave Week 2021 (EUMW2021)
April, 2-7
@London (UK)

Graphene Flagship WP3 meeting
February 14-17
@Gran Canaria (Spain)

Terahertz Technologies and Application Summer School (TTASS)
July 11-5
@Warsaw (Poland)

European Microwave Week (EURAD)
September 25-30
@Milano (Italy)

Upcoming Events

IET Radar 2022 conference
October 24-27
@Edinburgh (UK)

All past and upcoming events can be found on the Car2TERA official webpage:

car2tera.eu/events

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