

PROJECT RESULTS

CT209

Advanced silicon platforms for RF, MMW and THz applications a reality [RF2THz SiSoC]

Having first investigated the potential and capabilities of three silicon system-on-chip advanced technology platforms – radio frequency (RF), millimetre-wave (MMW) and terahertz (THz) – RF2THz project then developed critical electronic components and application demonstrators required by the consumer industry and by such diverse disciplines as health science, telecommunication, genetic screening, security and industrial automation.

There is no area of modern life untouched by the progress of microelectronics. Thanks to its advances, new market opportunities are emerging in Europe, characterised by the need for products and services offering both mobility and connectivity. Europe has a solid industrial base, especially in telecommunications, home electronics and automotive, and is well profiled for this future growth. This is reflected in one of the aims of the RF2THz project – to establish a European approach for gigabit data communications and automotive radar developments, which improve European competitiveness against USA and Japan vendors.

Key technology platforms with demonstrators

Using results obtained from several previous MEDEA+ projects as its basis, RF2THz investigated the potential and capability of three advanced technology platforms: 55nm SiGeC BiCMOS from STMicroelectronics; the newest NXP BiCMOS which integrates Elite Passive devices; and the photonic devices based on the IHP SiGe BiCMOS.

It subsequently developed silicon technology platforms for emerging radio frequency, (RF), millimetre-wave (MMW) and terahertz (THz) consumer applications, such as:

- 77/120 GHz automotive radars;
- MMW imaging and sensing, fast-measurement equipment;
- 60 GHz wireless networking and fast-downloading systems;
- 400 Gbit/s fibre optics data communications systems;
- 4G photonic mobile communications and high performance RF wireless communication systems;
- Two-way satellite communications;
- Label-free biosensing.

In addition, findings were also deployed in critical electronic components, precise models for active and passive devices, and demonstrators needed for the aforementioned applications. This will enable the mass production in Europe of electronic circuits for these

applications and help to keep and grow the European development and engineering knowhow on advanced technology devices and circuit concepts and designs.

The three MMW/THz technology platforms focused on in this project highlighted:

- The integration and optimisation of the SiGe HBT and back-end modules developed in previous projects (FP7 DOTFIVE and MEDEA+ SIAM) into a new advanced core CMOS technology (55nm) in order to obtain a 0.5THz 55nm SiGe BiCMOS platform suited for RF, MMW and THz SOC applications;
- An integral approach, focusing on improvements and breakthroughs with respect to previous BiCMOS technology generations of the essential high performance passive RF components. The RF packaging and the required RF testing solutions have also been part of this technology development framework. The work in this module has been based on, and validated using, the newest SiGe BiCMOS technology;
- The development of silicon photonics devices for future silicon photonics foundry offerings. The work in this module has been based on, and validated using, IHP SiGe BiCMOS technology, and has been conducted with the objective of possible integration in the 0.5THz 55nm SiGe BiCMOS technology.

Ready for the taking

These technology platforms are now available in Europe for prototyping and production. Demonstrators have been developed to show potential of all three platforms for growing MMW and THz markets. These markets used to be based on so-called III-V semiconductor technologies, and therefore limited by high manufacturing costs, high power-consumption and the limited integration scale of associated technologies. Importantly, all this is changing rapidly, with silicon now being considered as the semiconductor material of choice to address such applications, thanks to the high innovation level of the project results.

PROJECT CONTRIBUTES TO

- ✓ Communication
- ✓ Automotive and transport
- ✓ Health and aging society
- ✓ Safety and security
- ✓ Design technology
- ✓ Process development
- ✓ More than Moore

PARTNERS

Advanced System Developments and User Services / Agilent Technologies / Alcatel Lucent (Now NOKIA) / Astra SES / Robert Bosch
 Bruco Integrated Circuits / CEA-LETI
 ENSICAEN / ESIEE Paris / Fraunhofer Institute / Grenoble Institute of Technology
 IEMN / IES / IHP / IMS
 MASER Engineering / Micram Microelectronic
 NEWTEC / NXP Semiconductors
 Salland Engineering / Silicon Radar
 STMicroelectronics / SynView
 Telecom Bretagne / TU Berlin
 TU Delft / TU Dresden
 TU Eindhoven / Uni Saarland
 Uni Siegen / XMOD Technologies

COUNTRIES INVOLVED

-  Belgium
-  France
-  Germany
-  Luxembourg
-  The Netherlands

PROJECT LEADER

Jean-Louis Carbonero
 STMicroelectronics

KEY PROJECT DATES

July 2011 - December 2015

Today, there are production projects involving BiCMOS55 customers, on fibre optics communications up to 100Gb/s; 77GHz automotive radar; and high speed instrumentation. One customer is already in production of several circuits addressing 100Gb/s communications; and seven customers are at prototyping level for circuits covering the other applications.

In addition, the BiCMOS55 55nm technology platform, including its PDK, is also available to all circuit designers; and new customers can use this technology for their product development.

As a side note, most of the circuits produced by the project achieved very high performance levels, making Europe a leader in the field of MMW and THz.

This project involved 33 partners, from Belgium, France, Germany, and The Netherlands, and represented an effort of 235 person-years. Strong cooperation and interaction among project partners lead to its success. It also generated more than 240 international publications – mostly co-authored by one or more partners – and played a part in international conferences.

New services, opportunities and momentum

Importantly, RF2THz created new market opportunities. It achieved this by offering:

- New services at a reasonable cost;
- Highly integrated solutions for wireless multi-gigabit data rate transmission;
- New capabilities for the transportation and security sectors;
- Intelligence in building control based on radar sensors;
- Introducing the worldwide most advanced high speed D/A-converter platform.

Thanks to RF2THz, industry is also expected to generally benefit in the medium term from new application areas and revenue streams. In developing and demonstrating industry-standard, silicon-technology platforms for a number of promising application domains, it provided project partners with excellent opportunities to address technological challenges in this

innovative field cooperatively, and to move up the learning curve. For example, designing integrated circuits for MMW and THz applications requires a different approach and methodology and set of tools. However, the experience gained from designing the demonstrators gives project partners a competitive advantage in developing future products in the MMW and THz application domain.

Significantly, the supply of silicon technology-platforms able to handle greater than 100 Gbit/s optical communications to serve the requirements of ultra-high speed communications will give momentum to European chipmakers and the telecommunications industry. These platforms are essential for the evolution of future high-speed communication products.

In addition to technical, commercial and financial advantages, RF2THz also delivers societal, environmental and security benefits. Development of 77/120 GHz radar sensors for automotive applications will boost road safety by enabling development of new driving aids such as MMW radar. Advanced SiGe BiCMOS technologies make automotive radar affordable for all price segments and hence to the broad society. Other applications include passive MMW imaging technologies for improved airport security, and intelligent building controls to reduce energy consumption, while providing enhanced user comfort. Demonstrators targeted automotive applications with very stringent quality requirements so that these technology platforms can serve as industry standards for such products.

Supporting a fundamental building block

In a nutshell, the RF2THz project strengthens Europe's electronics business and competitive-edge by supporting research and development in key silicon technologies and applications; it is also likely to contribute towards improving Europe's society and economic climate by the leveraging effect which is inherent to microelectronic technologies. After all, the semiconductor industry is a fundamental building block of the new economy.

