PROJECT PROFILE

T204: Advanced SiGe bipolar and BiCMOS technologies for wireless applications (ASGBT)

IC TECHNOLOGY INTEGRATION

Partners:

Alcatel Microelectronics
Alcatel SEL
Ericsson Microelectronics
Ericsson Microwave
IMEC
STMicroelectronics
Uni Bordeaux (IXL)
Uni Goteborg (CTH)
Uni Leuven (KUL)
Uni Stockholm (KTH)

Project leader:

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Key project dates:

Start: January 2001
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Countries involved:

Belgium
France
Germany
Sweden

Mobile telephony is the driving force in the market for radio frequency (RF) integrated circuits. Generally accepted forecasts indicate that the number of cellular telephones sold will exceed one billion in the near future. And, while CMOS has become the main process in the semiconductor industry over the past decade, BiCMOS is rapidly gaining ground for mixed RF-analogue chips. At the same time, SiGe technology is being promoted as the cost- and power-saving replacement for GaAs in tomorrow's high-speed devices. The goal of MEDEA+ project ASGBT is to develop bipolar and BiCMOS technologies for cost-effective production of ICs for portable terminals handling voice, image and data transmission.

Wireless technology – especially mobile telephony – is moving ahead at an extremely rapid pace. There is a constant demand for ever-higher bandwidth and transmission rates: 2.2 GHz for UMTS (universal mobile telephony system), 2.4 GHz for Bluetooth, 5.5 GHz for HiperLAN (the ETSI high performance radio local area network standard), and up to 20 GHz or more for future systems.

For mobile equipment, battery capacity limitations impose a need to minimise power consumption, which implies smaller device dimensions and increased integration. Both are being achieved by using process modules of the next technology generation. Increased integration and lower power consumption can be also achieved through the integration on chip of high quality passive components such as inductors and MIM capacitors.

The increased process complexity may result in higher cost but this will be balanced by superior performance and integration of more functions on a single chip. In addition, the replacement of gallium arsenide (GaAs) by silicon germanium (SiGe) will permit further increases in integration levels, while reducing power demand and cutting costs.

High-growth market

A substantial proportion of the terminals sold in 2002 will already be adapted to the new wideband code-division multiple access (WCDMA) standard, permitting communication by voice, image and high-speed data transmission. The volume of integrated circuits (ICs) needed for receivers alone will reach 300 million units in 2003. And, although GaAs continues to dominate for transmitting amplifiers, recent advances in silicon technology can significantly change this scenario, potentially adding a further 100 million units in the coming years.

Applications in areas such as wireless local area network (WLAN) systems, satellite- and radio-link equipment will not greatly increase the figures, but these sectors will benefit substantially from low-cost technologies driven by the cellular phone market. The developments foreseen in the two-year MEDEA+ A204 ASGBT project will therefore be of considerable importance to the manufacturers of high-speed communication systems – a fact that enhances the market relevance of the SiGe technology from this project.

The project consortium, co-ordinated by STMicroelectronics, brings to bear the complementary expertise of prominent European semiconductor manufacturers, systems houses and research institutes. Horizontal co-operation between the chip-makers and their associated researchers is thus reinforced by vertical collaboration with the systems houses, whose role is to define the performance requirements, provide guidelines on architectural constraints and use the results in their internal system projects as a means of validating the processes under real industrial conditions.

Spanning generations

Global competition to deliver mixed-signal system-on-chip devices for the target sectors is very fierce, so new developments must be rushed to market as soon as they become available, in order to fit into diminishing product life-cycle windows.

The proposal of the ASGBT team is to pursue a two-stage approach covering two device generations. As a first step, it concentrated on optimising the selective epitaxial growth (SEG) and non-selective epitaxial growth (NSEG) processes used to develop 0.35/0.25 µm SiGe bipolar and BiCMOS technologies under the earlier MEDEA T555 project, in which the main participants also co-operated.

At the second step, which is this MEDEA+ project T204 ASGBT, partners intend to proceed with the characterisation of 0.25 µm heterojunction bipolar transistor (HBT) modules based on silicon germanium carbon (SiGeC) substrates, to meet the 80 to 100 GHz frequency requirement for more advanced wireless and wired optical fibre transmission applications.

Demonstrator blocks for process evaluation will be designed and characterised to confirm that the 50 to 70 GHz HBT frequencies are adequate for the 2.2 to 5.6 GHz circuits needed to fulfil the most immediate market requirements.

As a further response to demands of electronic equipment manufacturers for cost cutting and space saving, the consortium aims to develop and integrate high quality passive components such as inductors, high-k capacitors and varactors (variable capacitors) on the same chip as the ICs. The project partners are investigating a wide range of dielectric materials, process variations and interconnect layouts in thick copper layers, with the aim of reducing resistance and increasing Q (ratio of reactance to resistance) values.

These active and passive devices produced within the project period will be further embedded in the same or higher resolution BICMOS processes. These will offer a practical means of reducing power consumption for the RF functions under existing radio communication standards, and will allow new systems to work at the higher frequencies foreseen in the industry roadmap.

Leading edge technology

ASGBT will thus help Europe to strengthen its position at the leading edge of GSM, Bluetooth, third-generation mobile telephony and high-speed transmission technology.

By focusing on the key system requirements of high bandwidth in combination with low noise levels and very low power consumption, the project will enable partners to manufacture RF processes with high performance active and passive devices at very competitive costs. This will ensure continuity of employment in the strategically important high-technology businesses involved and motivating the research partners to investigate further groundbreaking work for RF technologies.

The results will play an important part in bringing the general public access to affordable terminals offering enhanced audio-visual and data communication possibilities, plus easy interactive connection to future implementations of the Internet.

The effort to achieve even higher HBT speeds in the longer term is also continuing. In fact, first trials of a 160 GHz transistor will be implemented through ASGBT. This work will pave the way for tomorrow's 12 GHz satellite communication networks, 20 GHz radar and vehicle distance control systems – and for digital data transfer at ultra-high bit-rates over optical fibre networks.

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