Research and development of wireline and wireless physical layer components and subsystems

J. Bauwelinck*, C. Mélange, X. Yin, B. Baekelandt, T. De Ridder, X.Z. Qiu, J. Vandewege

[1] IMEC/INTEC, Ghent University, Sint-Pietersnieuwstraat 41, Gent, Belgium

* *Corresponding author*: Phone: +32 9 264 3346, Fax: +32 9 264 3593, E-Mail: johan.bauwelinck@intec.UGent.be

Abstract – *This paper presents an overview of the various research activities at INTEC_design. In this lab, high-frequency electronic components and subsystems are designed for the physical layer of emerging wireline and wireless applications.*

Introduction – INTEC_design is one of the research groups of the Department of Information Technology (INTEC) at Ghent University and an associated laboratory of IMEC [1].

The INTEC_design lab is specialized in the design of high-frequency and high-speed electronic and opto-electronic circuits and systems. It has gained extensive experience by the study and development of innovative physical layer components and subsystems, and associated instrumentation for wireless, wired and broadband optical access networks.

The development of such prototypes and demonstrators requires the ability to trade off system level requirements with implementation details and a combination of various skills in a multidisciplinary team:

- System modeling, architecture partitioning and subsystem specification.
- Board level design of complex mixed analog/digital systems using commercial off-the-shelf components, taking care of signal integrity challenges.
- Transistor level circuit design on chip in CMOS and BiCMOS technologies. INTEC_design is one of the few university labs certified by ST microelectronics.
- Package and interconnect modeling, including 3D electromagnetic simulation.
- Experimental characterization of high-frequency, low-noise, and high-linearity circuits and systems.

This broad expertise is the basis for the successful development of various applications, beyond the state-of-the art.

Ranging-enabled RF transceivers – Well-established technologies for position determination are mostly addressing outdoor scenarios, such as global positioning system (GPS). Indoor, a high number of reflections and often obstructed lines-of-sight, complicate the time-of-arrival estimation of the transmitted signal.

A proof-of-concept ranging transceiver, shown in Fig. 1, was developed comprising both the analog front-end and the digital signal processing in FPGA. In a number of field trials in warehouse-like environments and harsh industrial environments this prototype showed a significant improvement in precision (<1m) compared to existing technologies.

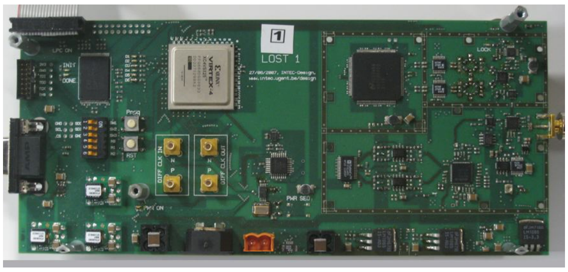


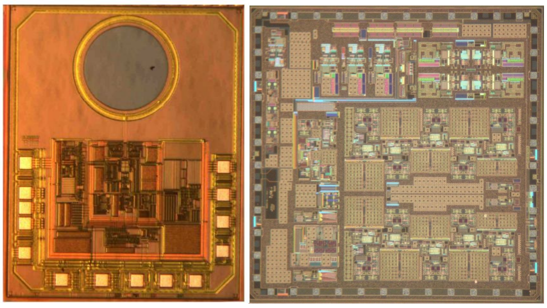
Fig. 1.: PCB demonstrator of a 2.4GHz ranging transceiver

On-going research

Automotive optical networks – Fiber optic networks will bring many advantages into the automotive environment, such as lower weight, higher data rates and improved electromagnetic compatibility.

A number of transmitters (VCSEL drivers) and receivers that comply with the MOST standard were developed for POF and PCS fibers. Ongoing research targets higher data rates (150Mbps, 1Gbps). An important challenge in this application is the extreme low cost requirement. For this reason, the photodiode was integrated into the silicon receiver chip, as shown in Fig 2(a).

Broadband over power line –Broadband over power lines (BPL) aims to offer low-cost broadband communications over the ubiquitous power grid. Within the IST project POWERNET, INTEC_design was mainly responsible for the specification and development of the analog front-end transceiver chip, shown in Fig. 2(b) [2].



(a) **(b)**

Fig. 2.: Die micrographs (a) a Silicon photodiode monolithically integrated with a transimpedance amplifier (b) BPL analog front-end transceiver chip

This novel design pushed the BPL frequency range from 30MHz up to 60MHz and achieved the highest dynamic range (99.5dB) available to date. The chips were integrated in modems, and evaluated in field trials. These new modems outperformed state-of-the-art commercial modems, and the technology complies with the emerging IEEE P1901 standard.

Passive optical networks (PONs) – PONs are one of the most promising solutions for fiber-to-the-premises (FTTP) applications, as feeder and central office costs can be shared by multiple customers. Within the framework of the EU-funded FP6 IST PIEMAN (Photonic Integrated Extended Metro and Access Network) project an optically amplified, large-split, long-reach PON is being developed [3]. This PON offers a high capacity hybrid wavelength division multiplexing/time division multiple access (WDM/TDMA) physical layer, integrating access and metro networks into one system. Within this framework three 10Gbps burst-mode (BM) ICs with advanced features have been designed by INTEC_design, shown in Fig. 3.

Beyond PIEMAN, INTEC_design continues the development of an advanced APD-based BM-TIA with high sensitivity and a wide dynamic range for a symmetric 10Gbps PON. This activity aims to comply as much as possible with the emerging 10Gbps ITU-T 10G-XGPON2 standardization.

Furthermore, INTEC_design is involved in the EU-funded FP7 ICT EURO-FOS Network of Excellence [4]. This is a perfect platform to continue our R&D on the design of innovative 10Gbps BM ICs and their subsystem integration.

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References

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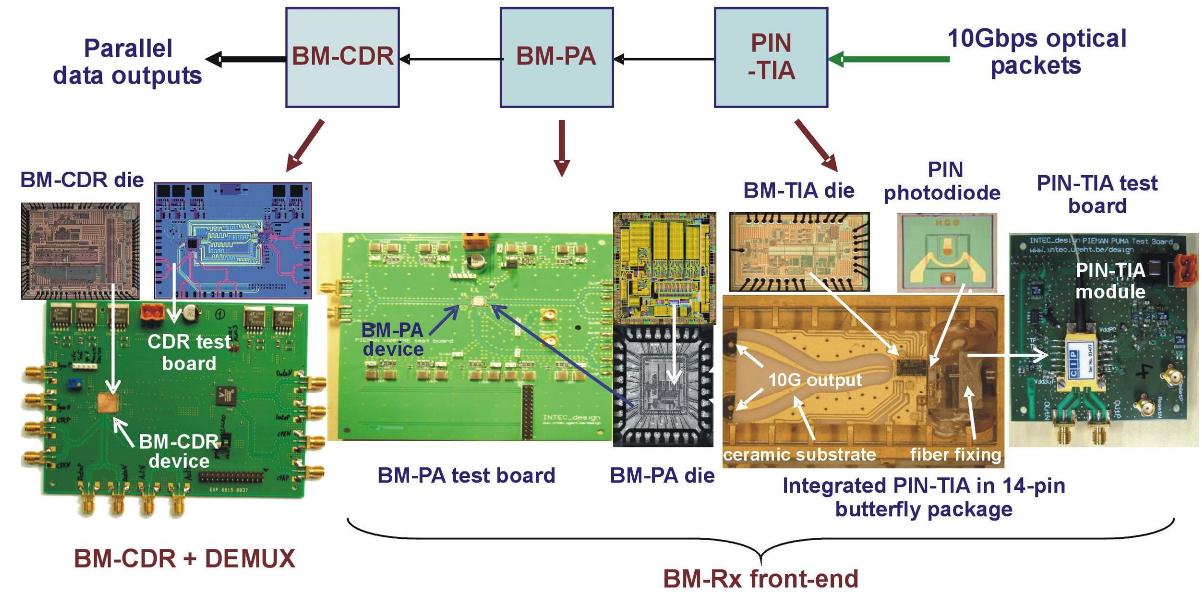

Fig. 3.: 10 Gbps burst-mode OLT prototypes developed in the IST PIEMAN project: BM-transimpedance amplifier (BM-TIA), BM-limiting amplifier (BM-LA), BM Clock and Data Recovery (BM-CDR)