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A multi-disciplinary project to combine electronic design and photonics

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Abstract

We present a project offered to Master students in Electronics Engineering or Communication and Computer Network integrating electronics and photonics. Teams, with different background knowledge, design independently an optical link following specifications provided by teachers. © 2021 The Author(s)

1. Introduction and goals

Photonics is pervading different fields of engineering thanks to the enormous impact it has on communications, electrical interconnects, sensors and biomedical engineering. Therefore, it is becoming an important background knowledge for those students pursuing a Master Degree in Electronic Engineering or in Communication and Computer Networks, who however do not intend to specialize in optics or photonics domain. These students could indeed benefit in their future careers of general knowledge about photonic technologies, as far as they will be able to read the opportunities offered by photonics as key enabling technology, to understand its impact on the various application domains and eventually to be able to understand the technical language of the experts in the field. However, it is difficult to capture the interest of this student courtyard, which attends with enthusiasm other courses in the domain of digital electronics, electronic systems design, analog and power electronics. Sometimes photonics is seen by them as a “niche” that has very few to share with their main domain of specialization. To attract the interest of these students and make them able to apply their “electronic design” skills to photonics, we have proposed a multi-disciplinary project for the realization and test of an optical link, to be realized in an education electronic laboratory of our department [1]. The laboratory is intended for education only and provides electronic instruments for testing, at low speed (<200 MHz), electronic circuits. A few optical spectrum analyzers, wavelength meters, optical power meters and laser temperature and current controllers are also present (Fig.1). During the project the students have free access to the laboratory to learn by themselves the use of optical instruments and to test themselves in the characterization of the optical components that will build up the link. The project has also the goal to encourage the students to work in team by sharing the knowledge they got attending different courses of their curricula.

2. The project: interdisciplinary (or) shop *+eali!ation o, lo - speed optical lin) and testing.

The optical link consists in a commercial transmitter optical sub-assembly (TOSA) made of a distributed feedback laser (DFB) integrated with an electro-absorption optical modulator (EAM) that can be modulated up to 10Gbit/s. However, to make the link compatible with the instrumentation of the electronic lab it is designed for data transmission at maximum speed of 180Mbit/s. The receiver is a low noise photoreceiver (New Focus Models 1811 125-MHz, [2]). Optical fiber for the link can be either single mode or multi-mode. The link will be tested in terms of bit error rate (BER) varying the length and attenuation of the link and the optical fiber (multimode or single mode); the BER tester has been designed and realized via a FPGA that generates the bit stream, reads the received bits and calculates the BER. Students were required to characterize the optical components of the link, design the driver of the TOSA for direct modulation of either the DFB or the EAM, design the interface circuit between the receiver and the FPGA at the receiver side. The project has concluded with the layout of the PCB and the generation of the BOM for the realization of the boards. The boards are now under realization and will be tested in the entire link by new teams of students during the next academic year. Requested deliverables during the project are periodic presentations of the advancements, final design of the boards and a conclusive video to present the project and the results obtained to other students of the same Master Degree.

The project is offered to the students of the first year of the master's degree in Electronic Engineering, and of the second year of Master Degree in Communication and Computer Networks, both in Politecnico di Torino; we indicate this students' group as courtyard in the following. The project is coordinated and sponsored by the Department of Electronics and Telecommunication together with the Interdepartmental Center PhotoNext (research center for applied photonics at the same university). The project is optional and gives four additional credits. Students work in teams of three; the students of each team not necessarily must have the same background and may have attended different courses during their career of the Master Degree. Students can form independently their team, provided that the whole team satisfies the requirements summarized in Table I. With this set-up we guarantee in each team some basic knowledge on optical components and optical communication that can be transferred by the students themselves to the other members of the team who have no photonic course in their background. Vice versa, students very skilled in electronic design will have to transfer their knowledge to those more expert in optics.

Table I - Composition of the team

| Student | Mandatory course to be attended during the first year | Knowledge and skills to bring in the team |
|--------------|-------------------------------------------------------|--------------------------------------------------------------------------------|
| # student 1 | Analog and Power Electronics | Electronic circuit: design and testing |
| # student 2 | Optoelectronics | Optical components: physics and performance |
| # student 3 | Optical transmission laboratory | Optical communication: testing optical components, link design and performance |
| All students | Electronic measurements | Familiar with testing of electronic circuit |



Fig.1 Optical set-up for the characterization of the photoreceiver

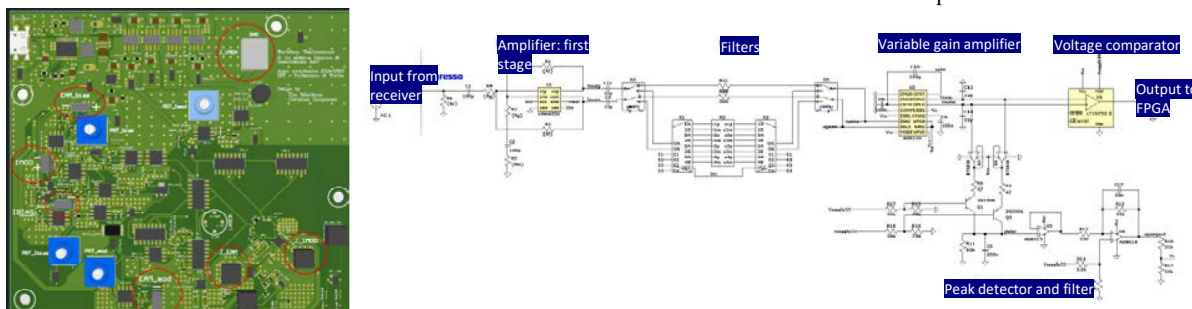


Fig.2 Examples of project results: (left) designed driver board and (right) PSpice schematic of the receiver interface

4. Conclusions

The project has already run for two academic years and 15 students have participated in total. All students have been successful in meeting the requirements and have obtained the final additional credits. Students' feedback has been very positive: they appreciated the possibility to merge the knowledge and skills acquired by attending different courses that, before this project, seemed to be very separate disciplines.

5. Reference

[1] Politecnico di Torino, Laboratori Esercitazioni Didattiche (LED), url: http://led.polito.it/default_en.asp
 [2] https://www.newport.com/medias/sys_master/images/hcc/h23/8796988538910/1801-1811-User-Manual-RevG.pdf