Project-Oriented Training of Engineering Students on MMIC and HMIC at LHOG/INPG

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Abstract

There is a huge development in mobile communications in Europe and consequently, the need for training engineering students in microwave design is growing. We present here some student projects aimed at designing microwave subsystems in MMIC and HMIC technology, for different wireless communications applications. They have been performed at LHOG/ENSERG (INPG), France. The capabilities and constraints of our university are presented, as well as the industrial partnership on these student projects. The facilities provided by complementary research on these topics are also discussed.

1. Introduction

The huge development in mobile communication systems leads to a growing need for training engineering students on microwave communications. The need of industry for hiring engineers specialized in the design of microwave systems leads us to develop project-oriented training in tight relationship with industry. The engineering projects presented here are aimed at designing microwave transceiver modules for frontend reception systems. The projects topics are in direct links with industrial requirements, needed for mobile systems in wireless communications, such as MBS, GPS, and satellite communications systems.

We present here results of three global training periods of 48 hours each on microwave design for engineering students. It is focused on three projects:
- linear and non linear MMICs design
- microwave transceiver in HMIC technology
- active filter for GPS reception.

The two different approaches, design in MMIC or HMIC technology are addressed. The requirements of industry for each of the three project are discussed. The basis of collaborations for our engineering school with industry are presented on special microwave techniques such as on-wafer noise measurements in silicon technology. We also present the facilities provided by complementary research activities in microwave design and microwave modeling of silicon devices.

These training periods have been made at the LHOG (Laboratory of Microwaves and Guided Optics), a laboratory of the ENSERG-INPG (Electronics Engineering School at the National Polytechnics Institute of Grenoble, France).

In microwaves, the capabilities of LHOG in training stand on the high-level equipment in CAD and testing of electronic analogue circuits working in the range 50 MHz-26 GHz, fast logic circuits working in time domain (commutation time less than nanosecond) and monolithic microwave integrated circuits on GaAs.

For guided optics at LHOG/INPG, we have developed practical work, concerning monomode and multimode integrated optics characterization, optical bistability, OTDR measurements, and YAG laser study.

2. Training on design of MMICs

Intensive training has been carried out at LHOG for the design of linear and non linear MMICs such as amplifiers, mixers, and VCOs [1, 2].

The academic constraints in training students on MMICs consist mainly in the fact that, due to the delay in the circuit fabrication, students do not have time to test their own circuit within the same year.

3. Training on design of HMICs

A TV satellite transceiver in the Ku microwave band has been designed, fabricated, and tested by the students (Fig. 1). This year, only the RF low-noise amplifiers have been designed. The required performances were 23 dB of gain, SWR of 1.2, and less than 2 dB of noise in the frequency range 10.95 - 12.75 GHz. This has been achieved in a microstrip technology by means of microwave balanced 2 stages - amplifiers (Fig. 2). The simulated gain is shown in Fig. 3. These results are in good agreement with measurements.
4. Design of active filter for GPS reception

A GPS low noise preamplifier has been designed, in the frequency range of 0.5 - 2 GHz, with the following performances: gain of 26 dB, noise factor of 1.5 dB, SWR of 1.2, frequency rejection of 25 dB at 1.6 GHz with a selectivity of 140 MHz. Then, the circuit has been realized and tested by the students, in a microstrip technology and with available commercial components.

5. Needs and expectations of industry

The projects presented previously are in many cases driven by industry, but are performed at university by undergraduate students, during their training periods. The required performances of the circuits are given by industry and SME. Then, at the end of the training period, the industrial partner may hire the students, for job in industry. The relations between industry and engineering students are very important for both industry and university sides. But, to maintain a high quality training, the university should benefit of extended financial help from industry.

In the microwave domains, industry expects some expertise from engineering schools. For example, noise evaluation is of great importance in the microwave transceiver module described here, and SME are not often equipped to make this type of measurements. The noise evaluation is performed by engineers of SME and by trainees in our lab.

6. Facilities provided by complementary research

Silicon technology offers promising performances in the gigahertz range, thus allowing a possible development of MMICs in the future. But, due to the rapid increase of performances, for example of BiCMOS circuits, the investigation of microwave on-wafer measurements is quite recent [3], especially for noise evaluation. The academic research is of great help in this field [4], and since engineers are needed on job in industry, the help of academic research in training engineers on these techniques is very useful.

References