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XXXV Cycle

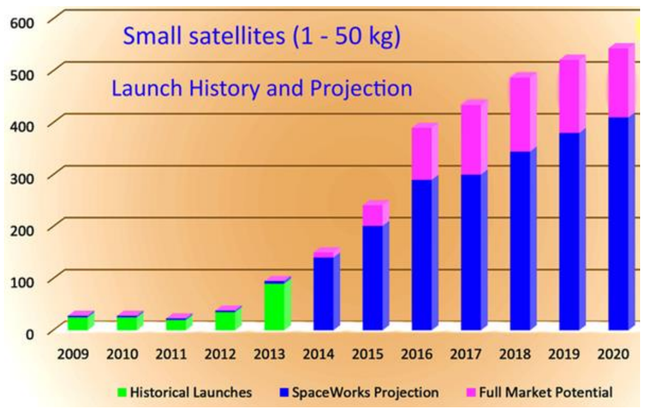
Realization and Characterization of an S-Band Transceiver for CubeSat

Abbas Nasri

Supervisor: Prof. Marco Pirola

Research context and motivation

- The number of satellites increases every day because of easier access to space. Small satellites are among the fastest growing classes of satellite in the last decade because of low cost components, short development time, and availability of launch opportunities.
- The tendency to use small satellites instead of large and traditional satellites increase more.
- One standard CubeSat unit (1U) is 10 cm x 10 cm x 10 cm in volume and less than 1.5 kg in weight. Common CubeSat sizes are 1U, 1.5U, 2U, 3U.



Addressed research questions/problems

- The goal of this work is to design a transceiver for S band frequency.
- The design have been carefully and synergically chosen by all the partners of the consortium considering the market requirements, but also the feasibility of the proposed figures of merit and performance achievable with the devices and technologies presently available.

Published works

❑ Publications

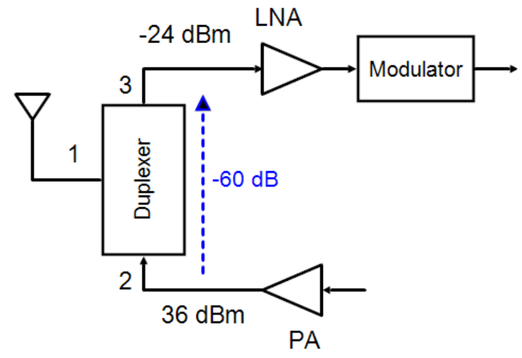
1. A. Nasri, M. Estebsari, S. Toofan, A. Piacibello, M. Pirola, V. Camarchia, and C. Ramella, “Design of a Wideband Doherty Power Amplifier with High Efficiency for 5G Application”, Published in Electronics, 2021.
2. A. Nasri, M. Estebsari, S. Toofan, A. Piacibello, M. Pirola, V. Camarchia, and C. Ramella, “Broadband Class J GaN Doherty Power Amplifier”, Published in Electronics, 2022.
3. C. Ramella, P. E. Longhi, L. Pace, A. Nasri, W. Ciccognani, M. Pirola, and E. Limiti, “Ultralow-Power Digital Control and Signal Conditioning in GaAs MMIC Core Chip for X-Band AESA Systems”, Published in IEEE Transactions on Microwave Theory and Techniques, 2021.
4. C. Ramella, M. Estebsari, A. Nasri, and M. Pirola, “GaAs-Based Serial-Input-Parallel-Output Interfaces for Microwave Core-Chips”, Published in Electronics, 2021.
5. A. Nasri, S. Toofan, “Analysis MOSFET Parasitic capacitances to Class-B Power Amplifier” Published in IEEE 27th Conference on Electrical Engineering (ICEE), 2019.
6. A. Nasri, M. Estebsari, S. Toofan, M. Pirola, “A 3-3.8 GHz Class-J GaN HEMT Power Amplifier” Published in IEEE Microwave and Radar Week conference, 2020.
7. M. Estebsari, A. Nasri, M. Pirola, “20W GaN Doherty Power Amplifier at 3.5 GHz” Published in IEEE Microwave and Radar Week conference, 2020.
8. Ch. Ramella, A. Nasri, M. Pirola, et al “Low Power GaAs Digital and Analog Functionalities for Microwave Signal Conditioning in AESA Systems” Published in IEEE International Workshop on Integrated Nonlinear Microwave and Millimetre-wave Circuits, 2020.
9. A. Veshaj, A. Piacibello, A. Nasri, M. Pirola, et al “Design Strategy of a 2.8-3.6 GHz 20W GaN Doherty Power Amplifier” Published in IEEE International Workshop on Integrated Nonlinear Microwave and Millimetre-wave Circuits, 2020

❑ Honor

The first-place in the Student Design Competition “Linear HPA Design with Behavioral Model” of the European Microwave Week 2020 Our design was rewarded with the first prize of 1500 US\$ made available by the prize sponsor MAURY Microwave.

Novel contributions

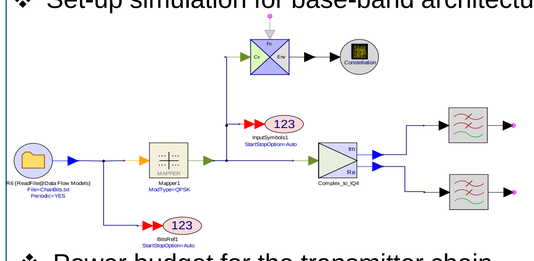
- The Goal of our work
  - —High output power
  - —Low noise figure
  - —High SFDR
  - —Small size
- Target of the designed transceiver:
  - —P_{out}=36 dBm
  - —Noise figure ≤ 2dB
  - —SFDR ≤ 80dB
  - —S band frequency



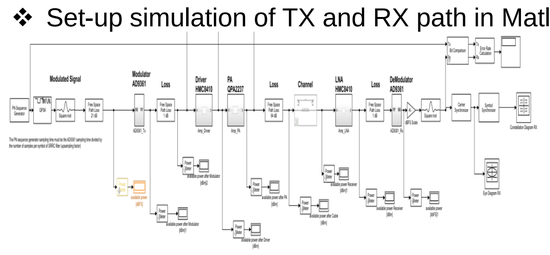
- CubeSate application at S-band frequency
- This project is supported by the Regional Project Ermes

Adopted methodologies

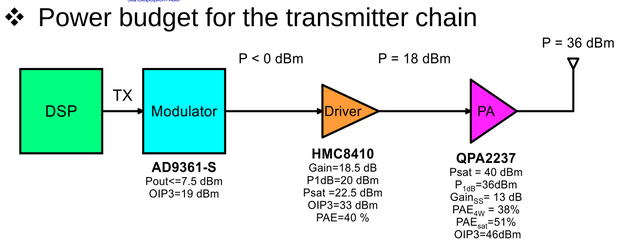
❖ Set-up simulation for base-band architecture



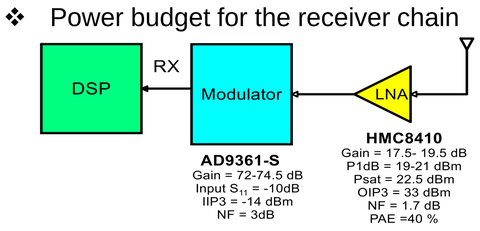
❖ Set-up simulation of TX and RX path in Matlab



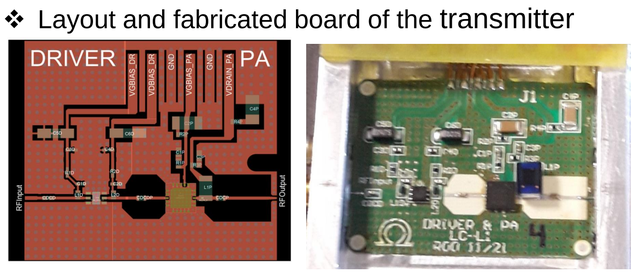
❖ Power budget for the transmitter chain



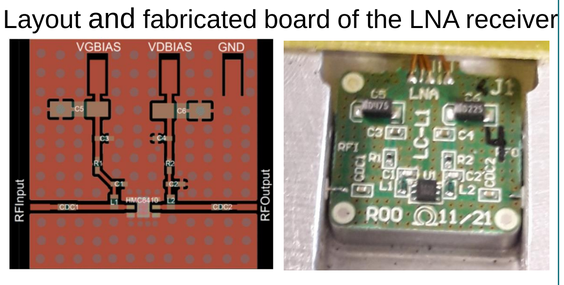
❖ Power budget for the receiver chain



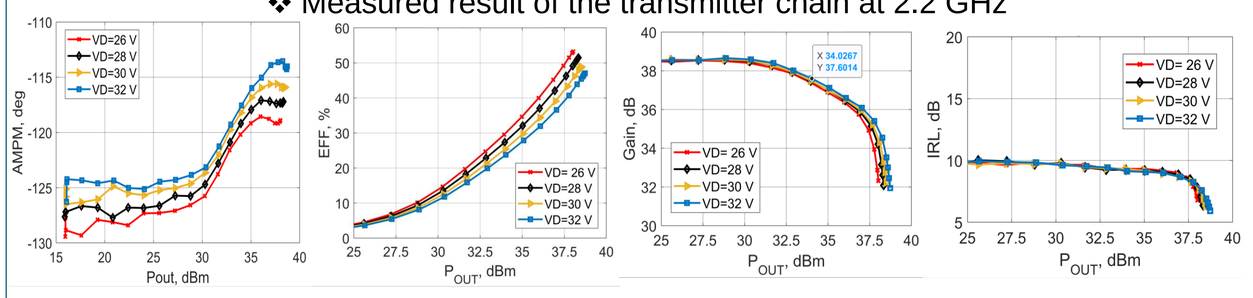
❖ Layout and fabricated board of the transmitter



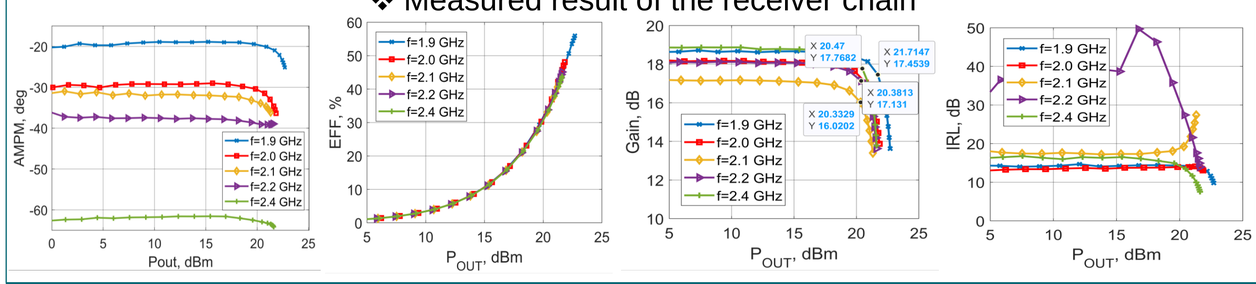
❖ Layout and fabricated board of the LNA receiver



❖ Measured result of the transmitter chain at 2.2 GHz



❖ Measured result of the receiver chain



Future work

- Design, simulation, and measurement of the transceiver for K-Band frequency

List of attended classes

- Advanced devices for high frequency application
- Theory and technology of semiconductor devices
- Wireless telecommunication system
- Advanced digital electronics
- Lingua italiana I livello
- The new internet society: entering the black-box of digital innovation
- Navigating the hiring process CV, tests, interview
- Managing conflict: negotiation and communication
- Research integrity
- Communication
- Public speak
- Time management
- Broadband circuits
- Personal branding
- Power electronic

Politecnico di Torino

PhD program in
Electrical, Electronics and Communications Engineering