IMEC Free Mini@sic Fabrication on TSMC 0.18 um Technology

Title of the Circuit: Analog and RF IP Blocks

Adviser Professor(s): João Navarro Soares Junior, João Paulo Pereira do Carmo

Students involved (names and aimed degrees)
1 – Rodrigo Henrique Gounella (MSc), sponsored by CAPES
2 – João Paulo de Campos da Costa (MSc)
3 – Talita Conte Granado (MSc), sponsored by CNPq

Institution: University of São Paulo (USP), São Carlos School of Engineering (EESC), Dept of Electrical Engineering (SEL)

Type of Circuit Design: ( ) Digital; (×) mixed signal; ( ) analog; (×) RF

Date of the circuit tape-out of the run:
Date of receiving the chips at your institution:
Date of the report: 15th August 2017

Short description of the circuit:
This die is composed by the following blocks:
1 – Reference voltage source: the proposed topology will allow a voltage source with these features: simple design, low power consumption (less than 2.0 μW), with a reasonable temperature coefficient (less than 20 ppm/ºC) and a very small line resolution (less than 1000 ppm/V). The circuit design and optimization employed metaheuristics in order to result on a circuit with an excellent throughput.
2 – A neural amplifier that was designed with the following characteristics: bandwidth between 1.0 Hz and 7.0 kHz, very low-noise referred to the input (less than 6.0 μV) and with a low power consumption (less than 5.0 μW).
3 – An array of photodiodes with structures on top for sensors to measure angles of incidence of the light and for gas detection and sensing.
4 – A RF switch, a programmable PN sequence generator and respective oscillator with PLL were fabricated to provide a sensing platform for chemical detection and measuring.
5 – Structures of photodetectors for optical characterization for future use on sensing platforms: floating N+/P-sub photodiodes, P+/N-well photodiodes, and a SPAD.

Main results:
Figure 1 shows a photograph of the fabricated CMOS microdevice on TSMC 0.18μm CMOS. This microdevice contains a reference voltage source, a neural amplifier, a matrix of 4×4 N+/P-sub photodiodes and respective readout circuit; it must be noted that on few photodiodes metal structures were placed above in order to provide optical diffraction and/or blocking; few metal structures will allow to measure angles and wavelength resolving; a fully programmable PN sequence generator, by a PLL for generating clock signals within the range 83-132MHz, and by a RF switch for the generation of RF pulses

with durations of 2ns; floating N+/P-sub, P+/N-well and SPAD photodiodes with and without readout electronics. Figure 2 shows the experimental results for the angle sensor. Figure 3 shows the output voltage of the reference source. The line sensitivity of the circuit is lower than 800 ppm/V.

Main challenges and difficulties encountered during design:

The main challenges were those one related to the bondingpads, with the ESD protections didn't provided within the PDK. Moreover, only next to the fabrication deadline it was informed the possibility to ignore the antenna rules. A huge amount of effort and work could be saved if this information was previously provided in the beginning of the design.

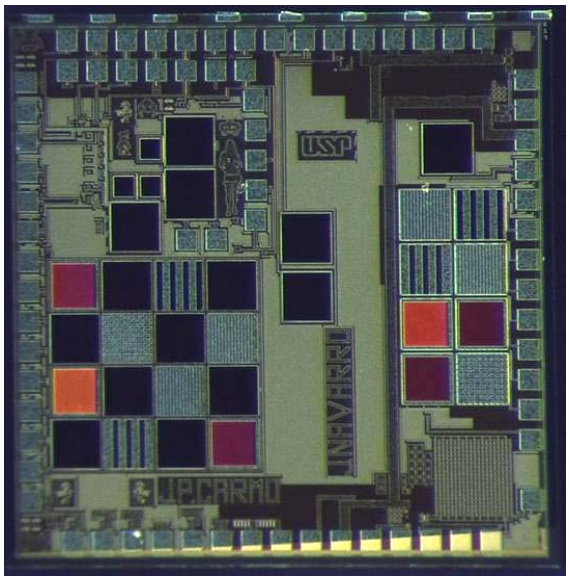

Figure 1

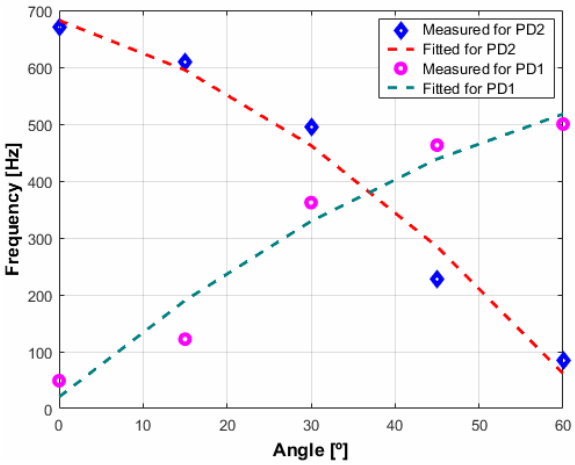

Figure 2

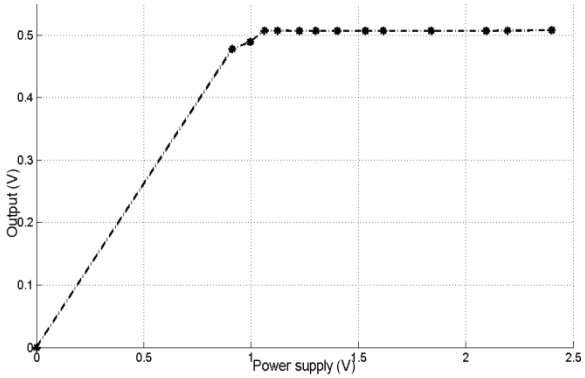

Figure 3. V_{out} versus power supply.

Accepted publications and degrees earned by students:

1 – J. P. C. Costa, R. H. Gounella, T. C. Granado, R. T. Machado, Y. A. O. Assagra, J. H. Correia, and J. P. Carmo, "Optical CMOS sensor for angular measurements with readout electronics", SBMicro 2017, Fortaleza – CE, Brazil. Accepted.

2 – R. H. Gounella, J. P. C. Costa, T. C. Granado, Y. A. O. Assagra, and J. P. Carmo, "CMOS developments for photonic modules on endoscopic capsules", IMOC 2017, Águas de Lindoia – SP, Brazil. Accepted.