Candidate: Filippo Boera

Thesis Abstract:

The current trends in the automotive market are pushing toward an ever increasing integration of electronic components in a car. Modern cars need to be safer and smarter, hence there is the need of a lot of sensors, radars, microcontrollers etc. Consequentially, the power supply circuits that are needed to power up all these devices starting from the 12-V battery of a car are also facing an intense thrust to integration. More integration of the power supply circuits means that the production costs and area of the components are significantly reduced, but leads to less flexibility of the circuits and less robustness to high temperatures. The traditional approach was to directly convert the battery voltage to each desired lower voltage using either low dropout regulators (LDOs) or switching DC-DC converters, depending on the application. Nowadays a post-regulated approach is preferred: one converter downshifts the battery voltage to an intermediate one, typically in the range of 4∼8 V, and that intermediate voltage can either directly supply some circuits, or be the input of multiple successive regulators, that will each power up the circuits that require lower supply voltages. While complicating the design, this approach is preferred due to a higher efficiency, and the possibility of a more robust thermal isolation of the circuits. Switching DC-DC converters are usually very expensive and bulky, and this is mostly due to the presence of the inductor, which can often cost more than the chip itself, both in terms of money and area consumption. The typical switching frequency of a DC-DC converter is a few MHz. By increasing the switching frequency, a much lower inductance value can be used without degrading the current ripple. Having a lower value of inductance means that the physical dimension of the inductor is smaller, resulting in an advantage in chip cost and area. In the field of power converters, efficiency is obviously another key parameter, especially in the field of automotive where a high efficiency is beneficial for both environmental and economical reasons. The main topic of this PhD research is the study and of this research is the study and the design of a buck converter with specifications aligned with the post-regulated domain, switching at 50/100 MHz. This work has been possible thanks to the collaboration between the University of Pavia and Infineon Technologies Italy, with help from both the Pavia and Padova sites.

The second topic of this thesis is the design of a Hybrid Single-Inductor Bipolar-Output DC–DC Converter with Floating Negative Output for AMOLED Displays. As AMOLED Displays have become one of the standard technologies for mobile and TV screens, the research for more compact and efficient solutions for the supplies of the pixels is thriving. As AMOLED displays need two supply voltages (one positive and one negative) to turn on, two separate DC-DC converters are typically used to provide the necessary voltages from the battery. A Single-Inductor solution can generate both voltages with only one inductor, hence saving a lot of money and area on the chip. This part of the work has been conducted thanks to the collaboration between the University of Pavia and the University of Macau.

Credits summary:

ACTIVITY	**CFU**
Seminars (17):	3.4
Ph.D Schools and Intensive Courses (50.5 hours):	10.1
Ph.D Schools Final Exams (2):	2
Secific Seminars (3):	1.5
Exams (1):	6
Conference Publications (2):	2
Journal Publicatios (1):	2
Conference Presentations (1):	1
Frontal Seminars (10 Hours):	2
Total	**30**

Publications:

- F. Mao, Y. Lu, E. Bonizzoni, F. Boera, M. Huang, F. Maloberti, R.P. Martins, "A Power-Efficient Hybrid Single-Inductor Bipolar-Output DC-DC Converter with Floating Negative Output for AMOLED Displays," 2020 IEEE Custom Integrated Circuits Conference (CICC), 2020, pp. 1-4, doi: 10.1109/CICC48029.2020.9075940.

- F. Boera, B. Pflaum, G. Torti, F. Maloberti and E. Bonizzoni, "On the Design of High Switching Frequency DC-DC Buck Converter Power Stages for Automotive Post-Regulated Applications," 2020 IEEE International Symposium on Circuits and Systems (ISCAS), 2020, pp. 1-4, doi: 10.1109/ISCAS45731.2020.9181199.

- F. Mao, Y. Lu, E. Bonizzoni, F. Boera, M. Huang, F. Maloberti, R.P. Martins, "A Hybrid Single-Inductor Bipolar-Output DC–DC Converter With Floating Negative Output for AMOLED Displays," in IEEE Journal of Solid-State Circuits, vol. 56, no. 9, pp. 2760-2769, Sept. 2021, doi: 10.1109/JSSC.2021.3062092.