Compact Architectures for DC–DC Converters with Galvanic Isolation

Radio Frequency Advanced Design Center

Ph.D. Student: Alessandro Parisi **Tutor: Prof. Giuseppe Palmisano**

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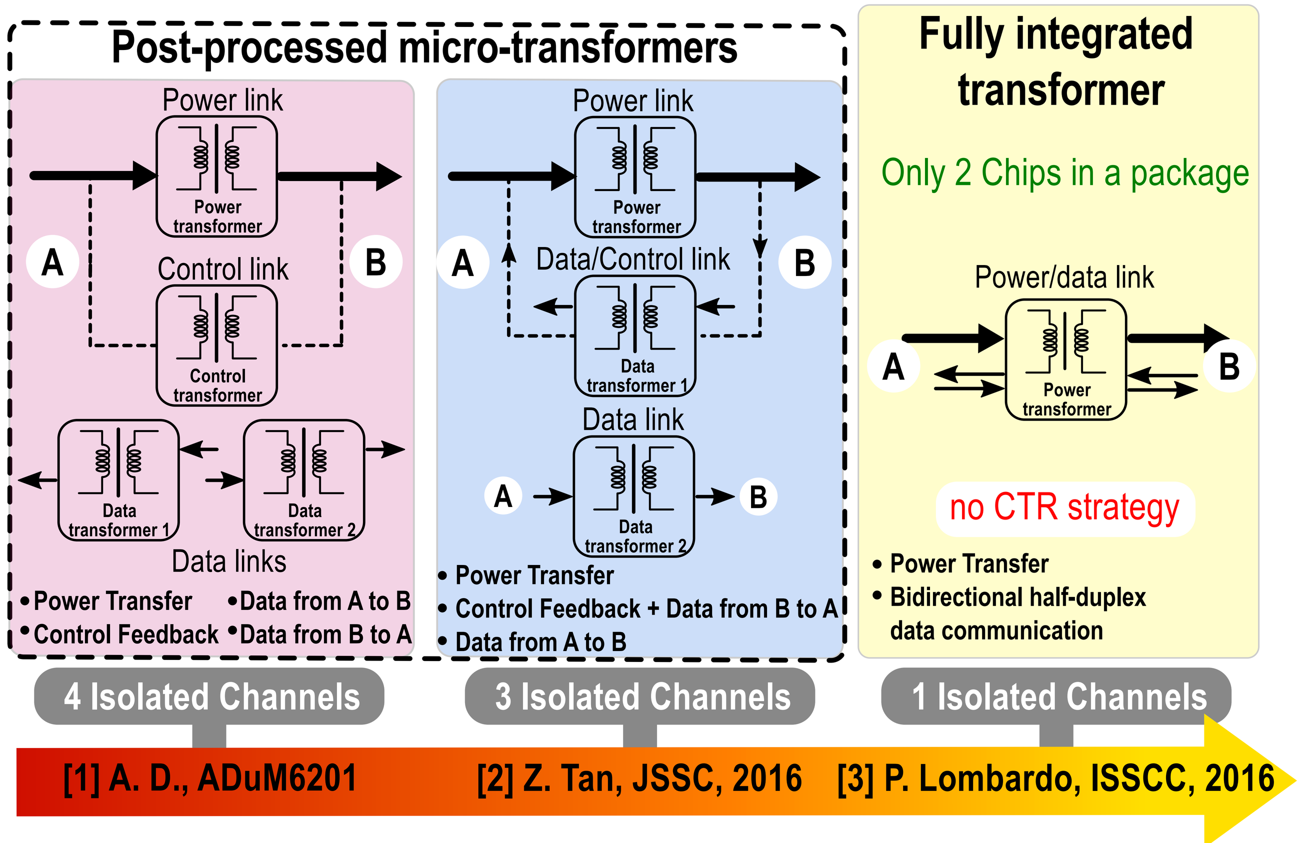
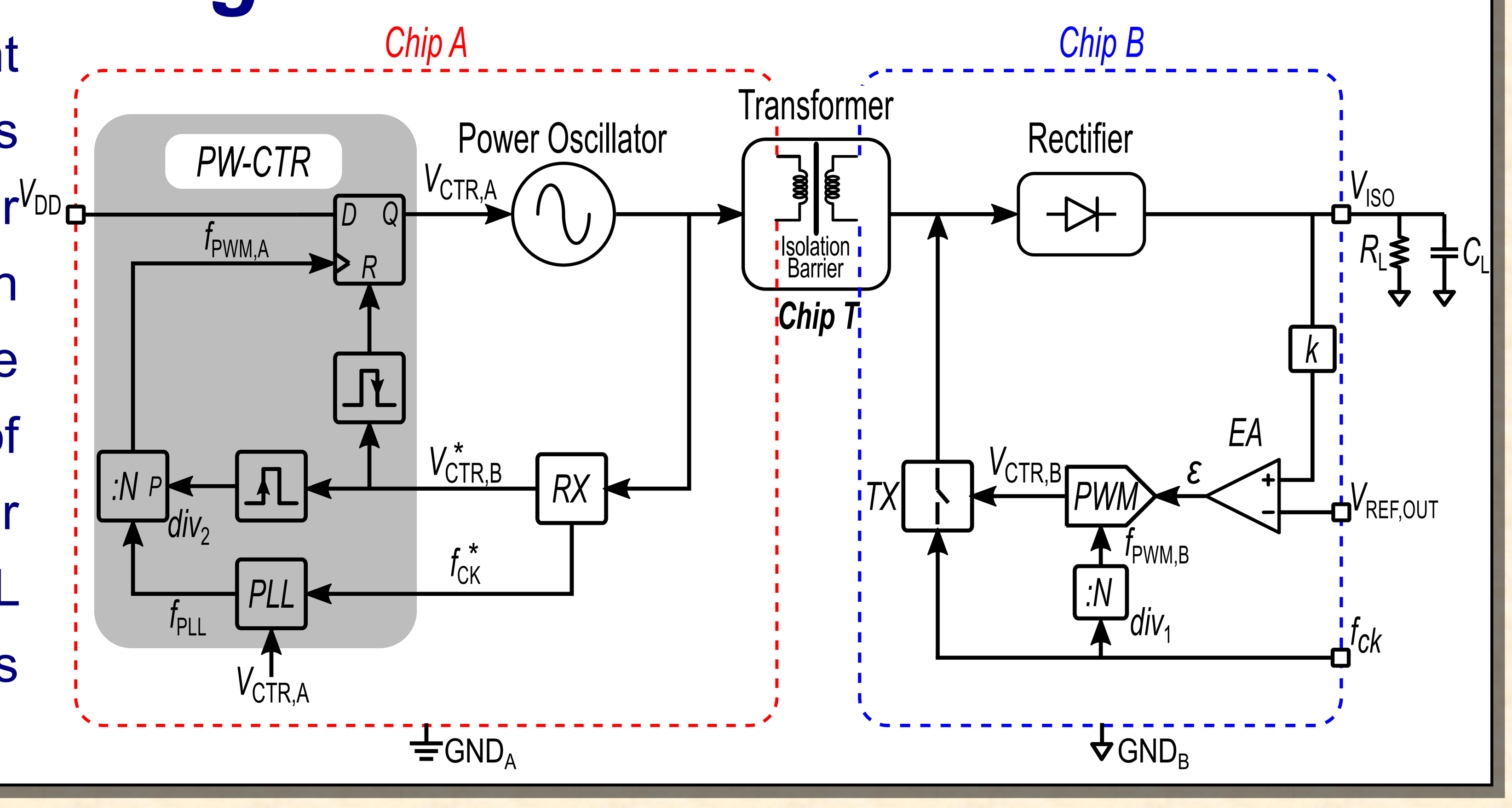
I. Introduction



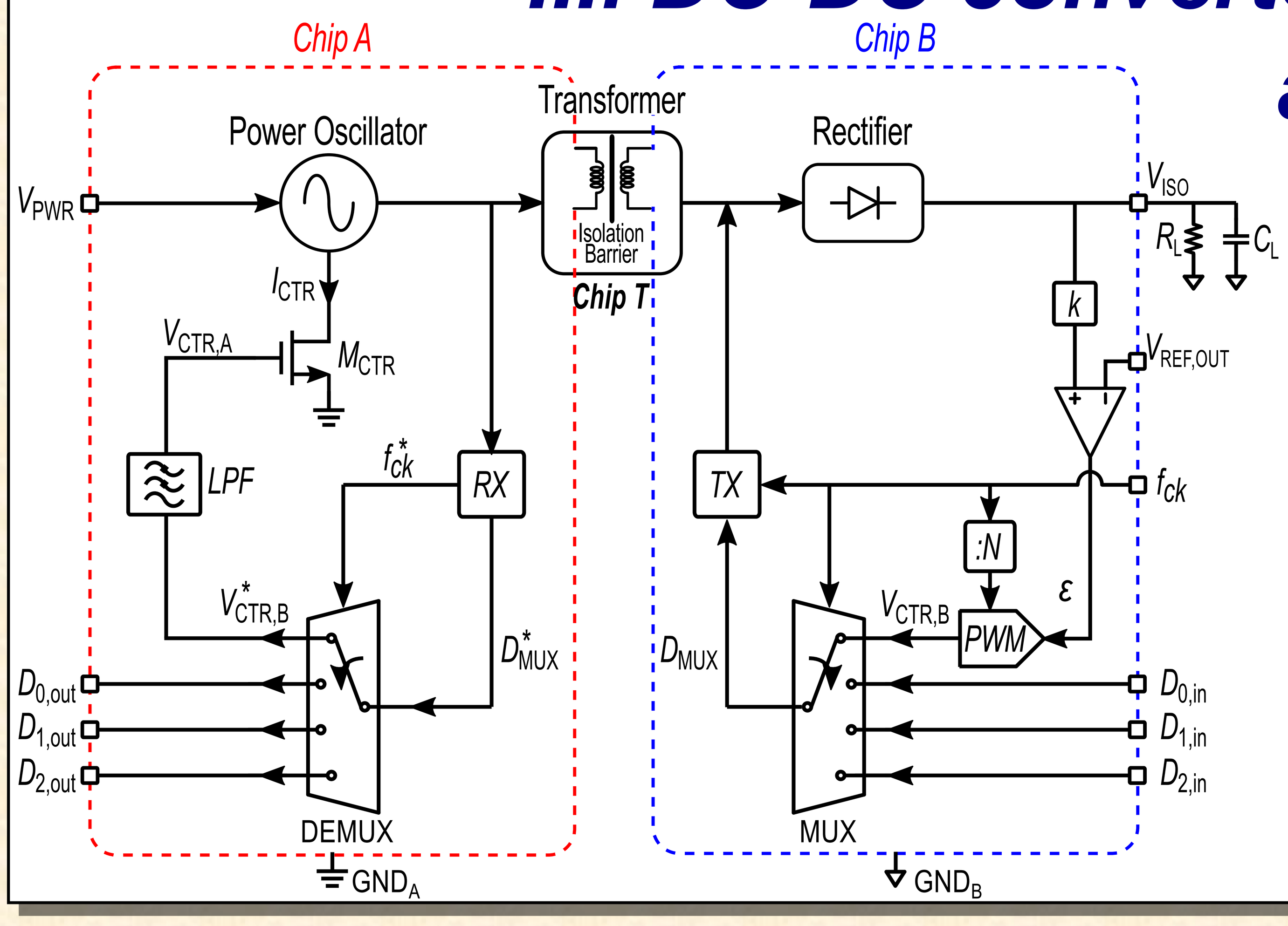
Recently, galvanic isolation for both power supply and data communication is becoming mandatory in several application fields (e.g., industrial sensors, medical equipment, etc.) to guarantee safety and reliability, especially in harsh operative environments. A galvanically isolated system consists of two domains, A and B, which are isolated since one of them is subject to hazardous voltages and/or requires a different ground reference. Data signals are transferred across the galvanic isolation barrier while power supply for domain B is provided from domain A by a power transfer technique. Typically, these architectures consist of a power channel, a power control link, and one or more data channels [1]. Several efforts have been made to reduce the number of isolated links [2], [3] thus decreasing both complexity and area occupation with advantages in terms of reliability and manufacturing costs.

II. DC-DC converter exploiting a single isolated link

The converter [4] consists of a single isolated link used both for highly efficient power transfer and control signal feedback loop. The dc output voltage is delivered to the external load, R_L-C_L, across the galvanic barrier thanks to a power link which is made up of a power oscillator operating in D class, an isolation transformer, and a power rectifier. A PWM control scheme is adopted to guarantee maximum efficiency regardless of the power level to be achieved. The feedback of the PWM control signal is performed by means of ASK modulation of the power signal. The correct reconstruction of the PWM signal is achieved thanks to a PLL which switches in open-loop condition when the power oscillator is turned off, thus maintaining data information when data transmission is not allowed.

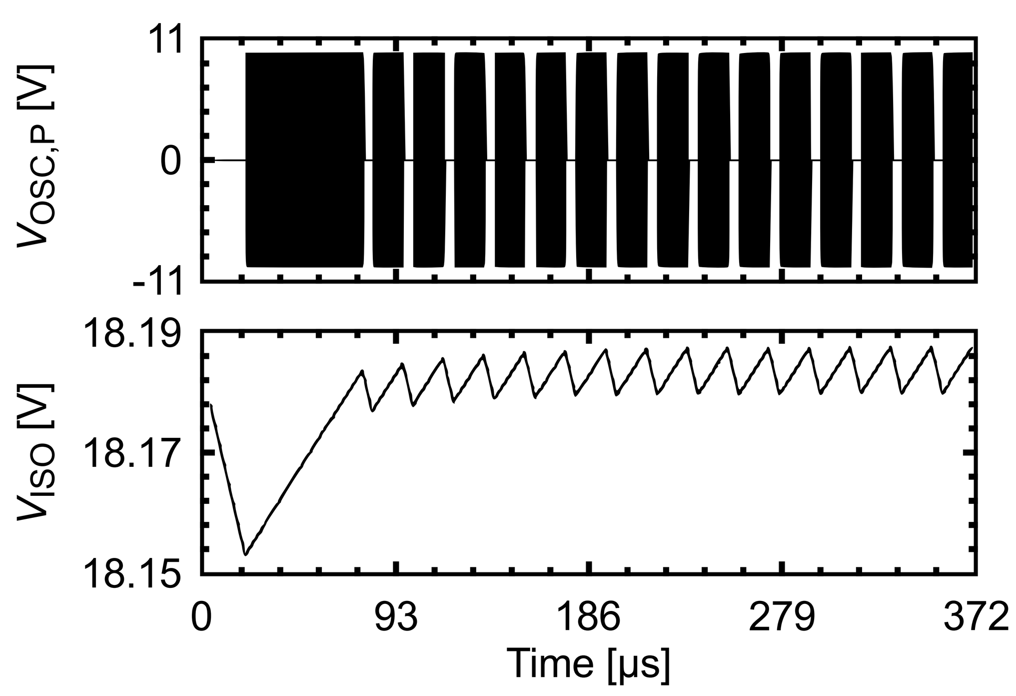


III. DC-DC converter with data communication exploiting a single isolated link

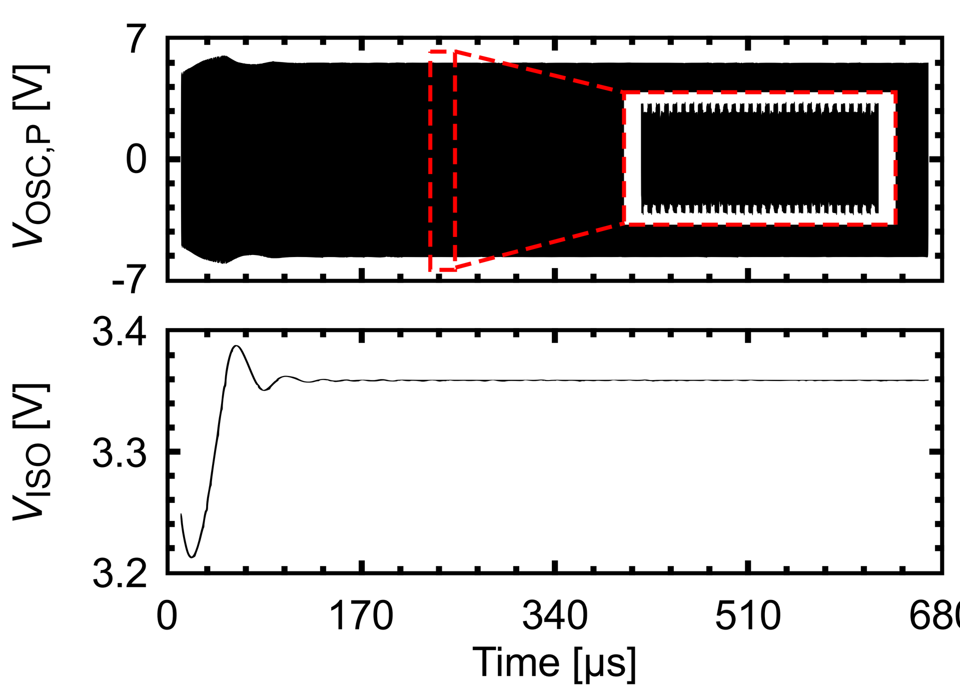


The proposed dc-dc converter [5] exploits the power link for both control feedback loop and data communication of N data channels, thus providing with only one isolated link all the required power and data functionalities that are: power transfer, multi-channel data communication and output power regulation. Differently from the widely adopted on/off control scheme, the dc output power is regulated by means of a continuous-time feedback loop, which allows power link to be exploited for continuous data communication besides power control. To this purpose, the power oscillator takes advantage of a current-controlled topology whose oscillation amplitude is set by the control signal. The latter is multiplexed with N data channels and transmitted across the galvanic barrier by means of ASK modulation of the power signal.

IV. Simulation Results



Power voltage oscillation at primary winding and isolated output voltage in closed loop condition of the system in [4]



Power voltage oscillation at primary winding and isolated output voltage in closed loop condition of the system in [5]

	[4]	[5]
Application	Gate Driver	Sensor interfaces
Supply voltage [V]	5	5
Isolated output voltage [V]	18	3.3
Isolated output power [mW]	130	50
Power efficiency [%]	25	16
Power&data funtionalities*	PT - PR	PT - PR DT (from B to A)
Control scheme	PWM	Continuous-time
Number of isolated links	1	1
Isolation technology	Post-processed polyimide transformer with thick Au metals	
Silicon technology	0.18-um BCD, 0.13-um CMOS	

*PT=power transfer, DT=data transmission, PR=power regulation

[4] A. Parisi, N. Greco, N. Spina, E. Ragonese, G. Palmisano, "A galvanic isolation circuit and system,corresponding method," IT P. Appl. 10201800000417, filed 3/04/2018
[5] A. Parisi, N. Greco, N. Spina, E. Ragonese, G. Palmisano, "A galvanically isolated dc-dc circuit converter, with data communication, corrisponding system and corresponding method," IT Patent Appl- 102018000000830, filed 12/01/2018