



UNIVERSITY OF CATANIA

Angelo Raciti, Giuseppe Scarcella, Mario Cacciato, Giacomo Scelba, Santi Agatino Rizzo, Giovanni Nobile, Giovanni Susinni, Giuseppe Aiello.

RESEARCH TOPICS

- PARASITIC OUTPUT CAPACITANCE IN MOSFET DEVICES
- OXIDE DEGRADATION OF MOSFET'S GATE
- WIRELESS POWER TRANSFER IN DRONE APPLICATIONS
- BULB LED LAMPS ELECTRIC EQUIVALENT MODEL
- FAULT TOLERANT - MULTIPHASE MOTOR DRIVES
- SELF-SENSING MOTOR DRIVES
- MULTI-LEVEL POWER CONVERTERS
- MODELING OF ENERGY STORAGE SYSTEMS
- FPGA-BASED REAL-TIME MODELS OF POWER CONVERTERS AND ELECTRICAL MACHINES

PARASITIC OUTPUT CAPACITANCE IN MOSFET DEVICES

Keywords: Coss; equivalent series resistance; hysteresis; parasitic capacitance; superjunction; zero voltage switching.

The Superjunction MOSFETs present a non-linear output parasitic capacitance (C_{oss}). It has an abrupt variation on varying the drain-source voltage. It has been carried out the MOSFET hysteresis characteristic in the Q-V plane. To take into account of the switches losses, an equivalent series resistance (ESR) has been considered. To improve the losses model, it has been considered also a non-linear resistor that provides a characteristic shape similar to the one obtained experimentally.

Reference

- [1]. Raciti A., Rizzo S. A., Salerno N., Susinni G., Scollo R., Scuto A., "Modeling the hysteresis power losses of the output parasitic capacitance in super junction mosfets", SPEEDAM 2018.

OXIDE DEGRADATION OF MOSFET'S GATE

Keywords: Gate oxide, MOSFET, oxide degradation

The research activity involves the studies of oxide degradation of the MOSFET's gate. Different methods are used in the scientific community, such as constant voltage, constant current, ramp voltage. More analysis will be performed in the next months, thanks to the use of specific machines/equipment.

WIRELESS POWER TRANSFER IN DRONE APPLICATIONS

Keywords: drone; MOSFET; resonance; variable inductance; wireless power transfer.

The research is focused on designing a power system for recharging the drone on-board battery regardless of the misalignment between the drone and the pad of the recharge station installed on a building roof. It was proposed a current tuning mechanism that compensates for the coupling factor variability. All the theoretical design has been validated by simulating the adaptive charging system.



Reference

- [2]. Raciti A., Rizzo S. A., Susinni G., "Drone charging stations over the buildings based on a wireless power transfer system", I&CPS 2018, Niagara Falls Canada, 2018, May 2018, pp. 1-6.

BULB LED LAMPS ELECTRIC EQUIVALENT MODEL

Keywords: active power; circuit model; current harmonics; lighting; power quality; PSpice; reactive power.

The aim of this research is to derive a possible electrical bulb LED lamp model, an equivalent PSpice circuit for the first harmonic of the current absorbed by the bulb lamps. Also, a simple and effective equivalent circuit was proposed, that it is able to model the total current of the bulb LED lamp, accounting for the current harmonics.

References

- [3]. Raciti A., Rizzo S. A., Susinni G., "Steady state electrical modeling of LED and CF bulb lamps under variable voltage on the mains", IEEE - EEEIC / I&CPS Europe 2018.
- [4]. Di Mauro S., Raciti A., Rizzo S. A., Susinni G., "LED lamp PSpice circuit emulating first harmonic current absorption as a function of the main voltage", SPEEDAM 2018.

FAULT TOLERANT-MULTIPHASE MOTOR DRIVES

Keywords: Fault-tolerant motor drive; safety-critical systems; losses minimization.

Development of fault-tolerant control strategies and loss minimization algorithms devoted to three phase and multi-phase electric drives are the key goals of this research activity; the technical solutions require very limited hardware reconfigurations and computational efforts. Fault tolerant rotor position and speed estimation algorithms for motor drives are investigated in collaboration with the colleagues of UNIROMA1.

References

- [5]. G. De Donato; G. Scelba; M. Pulvirenti; G. Scarcella; F. G. Capponi, "Low-Cost, High-Resolution, Fault-Robust Position and Speed Estimation for PMSM Drives Operating in Safety-Critical Systems", IEEE Trans. on Power Electronics, 2018.
- [6]. Nobile G., Scelba G., Scarcella G., Cacciato M., Salvo L., "Performance assessment of a novel integrated multi-drives topology for automotive applications", SPEEDAM 2018.
- [7]. G. Scarcella; G. Scelba; M. Pulvirenti; R. D. Lorenz, "Fault-Tolerant Capability of Deadbeat-Direct Torque and Flux Control for Three-Phase PMSM Drives", IEEE Transactions on Industry Applications, 2017, vol. 53, pp. 5496 – 5508.
- [8]. G. Nobile, G. Scelba, M. Cacciato, G. Scarcella, "Losses minimization control for an integrated multi-drives topology devoted to hybrid electric vehicles", IECON 2017, pp. 2059 – 2066.
- [9]. M. Pulvirenti, G. Scelba, G. Scarcella, M. Cacciato, L. Tornello, "On-line stator winding resistance and rotor permanent magnet flux estimation for dual-three phase PMSM drives", IECON 2017, 2017, pp. 2104 – 2109.

SELF-SENSING MOTOR DRIVES

Keywords: sensorless; PMSM drives, multiphase motor drive.

This line of research consists in enhance rotor position estimation carried out from conventional sensorless control algorithms in PMSM motor drives. The influence of magnetic saturation and temperature variation on the estimated rotor flux position are mitigated in some cases through a direct back-EMF measurement. The proposed methods do not require any motor parameter knowledge, do not require any additional high frequency test signals, and they can be used during normal drive operation.

References

- [10]. G. Scelba; G. Scarcella; M. Cacciato; M. Pulvirenti; A. Testa, "Compensation of rotor position estimation errors in sensorless dual-three phase PMSM drives through back-EMF sensing", 2017 IEEE - SLED, 2017, pp. 199 – 206.
- [11]. G. Scelba, G. Scarcella, S. Foti, S. De Caro, A. Testa, "Self-sensing control of open-end winding PMSMs fed by an asymmetrical hybrid multilevel inverter", 2017 IEEE - SLED, 2017, pp. 165 – 172.



MULTI-LEVEL POWER CONVERTERS

Keywords: AC motor drives, active power filter, harmonic reduction, multilevel inverter (MLI).

UNICT in collaboration with colleagues of UNIME is investigating open-end winding machine configurations with suitable control strategies for medium-voltage ac motor drives applications in order to reduce the distortion of phase voltages in multilevel inverters (MLIs). Differently than standard open-end winding configurations, a high efficiency step modulation manages the MLI, while the auxiliary unit is pulse width modulation (PWM) operated. As the phase current harmonic content is improved, the torque ripple is reduced and the drive efficiency is increased.

References

- [12]. S. Foti, S. De Caro, G. Scelba, T. Scimone, A. Testa, M. Cacciato, G. Scarcella, "An Optimal Current Control Strategy for Asymmetrical Hybrid Multilevel Inverters", IEEE Transactions on Industry Applications, 2018, IEEE Early Access Articles.
- [13]. S. Foti; A. Testa; G. Scelba; S. De Caro; M. Cacciato; G. Scarcella; T. Scimone, "An Open-End Winding Motor Approach to Mitigate the Phase Voltage Distortion on Multilevel Inverters", IEEE Transactions on Power Electronics, 2018, vol. 33, n.3, pp. 2404 – 2416.
- [14]. S. Foti, A. Testa, G. Scelba, V. Sabatini, A. Lidozzi, L. Solero, "Asymmetrical hybrid unidirectional T-type rectifier for high-speed gen-set applications", 2017 IEEE - ECCE, pp. 4887 – 4893.

MODELING OF ENERGY STORAGE SYSTEMS

Keywords: Adaptive algorithms, energy storage systems modeling, SOC, SOH.

Novel techniques for SOC and SOH estimation are investigated in this field of research in order to obtain a full exploitation of battery potential in energy storage applications by means of accurate modeling of electrochemical storage units. Battery circuit models are exploited to ensure a good accuracy in a wide range of operation. Because of the low computational burden of these algorithms, they can be easily implemented in low-cost control units.

References

- [15]. M. Cacciato, G. Nobile, G. Scarcella, G. Scelba, "Real-Time Model-Based Estimation of SOC and SOH for Energy Storage Systems", IEEE Transactions on Power Electronics, 2017, vol. 32, n. 1, pp. 794-803.
- [16]. G. Nobile, M. Cacciato, G. Scarcella, G. Scelba, "Performance assessment of equivalent-circuit models for electrochemical energy storage systems", IECON 2017, pp. 2799 – 2806.
- [17]. M Galád, P Špánik, M Cacciato, G Nobile, "Analysis of state of charge estimation methods for smart grid with VRLA batteries", Electrical Engineering, 2017, vol. 99 (4), 1233-1244.

FPGA-BASED REAL-TIME MODELS OF POWER CONVERTERS AND ELECTRICAL MACHINES

Keywords: real time simulation; power converters; motor drive; field programmable gate arrays.

The research activity is focused on the development of FPGA-based models of power converters and electrical machines for hardware in the loop systems. These models are implemented in order to keep minimal modeling complexity and thus reduced computational efforts, still maintaining high accuracy. The main target is to provide an easy model plant for testing electric drive configurations and control strategies, fault tolerant drives, and so on.

References

- [18]. Aiello G., Scelba G., Scarcella G., Cacciato M., Tornello L. D., et al., "Real-time emulation of induction machines for hardware in the loop applications", SPEEDAM 2018.
- [19]. Tornello L. D., Scelba G., Cacciato M., Scarcella G., Palmieri A., et al., "FPGA-based real-time models of IGBT power converters", SPEEDAM 2018.
- [20]. G Aiello, M Cacciato, G Scarcella, G Scelba, "Failure analysis of AC motor drives via FPGA-based hardware-in-the-loop simulations", Electrical Engineering, 2017, vol. 99 (4), pp. 1337-1347.