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### RESEARCH TOPICS

- Over-Voltage Mitigation on SiC based Motor Drives through Open End Winding Configurations
- Stress Analysis and Lifetime Estimation of Power MOSFETs for Automotive Systems
- PZT based Energy Harvesters with Working Point Optimization
- Multi-Level Power Converters
- Fault Tolerant – Multiphase Motor Drives
- Sensorless Field Oriented Control Of Multiple-Motors Fed By Multiple-Converters Systems
- Electrically Assisted Internal Combustion Engines

### OVER-VOLTAGE MITIGATION ON SiC BASED MOTOR DRIVES THROUGH OPEN END WINDING CONFIGURATIONS

*Keywords: Variable-speed drive, long cable, overvoltage, open-end winding motor drives*

Over-voltage occurring at the terminals of motor phases is mitigated by driving the two inverters of an open end winding configuration through a modified switching pattern including a suitable dwell time. No passive RLC networks are required, thus avoiding additional costs and extra power losses.

#### References

- [1] S. De Caro; S. Foti; T. Scimone; A. Testa; G. Scelba; M. Pulvirenti; S. Russo "Over-voltage mitigation on SiC based motor drives through an open end winding configuration", ECCE 2017.

### STRESS ANALYSIS AND LIFETIME ESTIMATION OF POWER MOSFET FOR AUTOMOTIVE SYSTEMS

*Keywords: stress analysis, lifetime estimation, reliability model*

An experimental technique is exploited to evaluate the stress exerted on planar power MOSFETs designed to equip automotive systems. The technique is based on an accurate experimental analysis of electro-thermal cycles, exploiting a laboratory tool tailored around an infrared microscope. It enables a high resolution dynamic temperature mapping with a large bandwidth.

#### References

- [1]. De Caro, S., Foti, S., Scimone, T., Testa, A., Scelba, G., Pulvirenti, M., Russo, S., "Over-voltage mitigation on SiC based motor drives through an open end winding configuration.", 2017 IEEE - ECCE.
- [2]. Russo, S., Testa, A., De Caro, S., Scimone, T., Panarello S., Patanè S., Scelba G., Scarcella G., "Reliability Assessment of Power MOSFETs Working in Avalanche Mode Based on a Thermal Strain Direct Measurement Approach", IEEE Transactions on Industry applications, 2016.
- [3]. G. Cannata, S. De Caro, S. Panarello, T. Scimone, A. Testa, S. Russo, "Reliability Assessment of Avalanche Mode Operating Power MOSFETs through Coffin Manson Law based Mathematical Models", SPEEDAM 2014
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### PZT BASED ENERGY HARVESTER WITH WORKING POINT OPTIMIZATION

*Keywords: Energy harvesting, Piezoelectric effect, AC-DC power converters.*

The research is focused on designing a new single-stage, low-power, converter able to automatically follow the variations of the resistive component of the output impedance of a



cantilevered PZT (Lead Zirconate Titanate) based piezoelectric energy harvester in order to maximize the energy yield.

#### References

- [1]. S. De Caro; R. Montanini; S. Panarello; A. Quattrocchi; T. Scimone; A. Testa, "A PZT-based energy harvester with working point optimization", 2017 ICCEP.

#### MULTI-LEVEL POWER CONVERTERS

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

Open-end winding machine configurations with suitable control strategies for medium-voltage AC motor drive applications are investigated in order to reduce the distortion of phase voltages in multilevel inverters (MLIs).

#### References

- [1]. 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.
- [2]. 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.
- [3]. S. De Caro, S. Foti, T. Scimone, A. Testa, G. Scelba, M. Pulvirenti, S. Russo, "Over-voltage mitigation on SiC based motor drives through an open end winding configuration", 2017 IEEE - ECCE, 2017, pp. 4332 – 4337.
- [4]. 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.

#### FAULT TOLERANT – MULTIPHASE MOTOR DRIVES

*Keywords: parameters estimation*

Fault-tolerant control strategies for three phase and multi-phase electric drives have been developed requiring very limited hardware reconfigurations and computational efforts.

#### References

- [1]. M. Pulvirenti, G. Scarcella, G. Scelba, A. Testa, M. M. Harbaugh, "On-line stator resistance and permanent magnet flux linkage identification on open-end winding PMSM drives", 2017 IEEE - ECCE, 2017, pp. 5869 – 5876.

#### SENSORLESS FIELD ORIENTED CONTROL OF MULTIPLE-MOTORS FED BY MULTIPLE-CONVERTERS SYSTEMS

*Keywords: sensorless machine control*

On Multiple-Motor systems fed by Multiple-Converter systems a set of electric motor drives share the load through a common mechanical coupling. Such a coupling is exploited to realize a sensorless field oriented control, based on a quite common back-emf technique to estimate the rotor flux angular position and an original approach to correct the estimation errors.

#### References

- [1]. S. Foti; A. Testa; S. De Caro; T. Scimone; M. Pulvirenti "Sensorless field oriented control of multiple-motors fed by multiple-converters systems", SLED 2017.

#### ELECTRICALLY ASSISTED INTERNAL COMBUSTION ENGINES

*Keywords: Battery lifetime, Electric Turbo-charger, Fuel Saving, Hybridization, Micro-cycles.*

An electrically assisted internal combustion engine is obtained by combining a conventional engine and one or more electrical motors do not delivering, directly or indirectly, torque to the wheels. A tool to evaluate different possible solutions in terms of energy balance, efficiency, battery stress and battery ageing has been developed.

#### References

- [1]. De Caro S., Scaffidi C., Scimone T., Testa A. "Energy balance assessment on vehicles with electrically assisted internal combustion engines" ICCEP 2015