

ROMA TOR VERGATA

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RESEARCH TOPICS

- Power Electronics for Smart Electricity Networks
- Sensorless Control Of Permanent Magnet Machine for High Efficiency Variable Speed Pump-Fan Applications

POWER ELECTRONICS FOR SMART ELECTRICITY NETWORKS

Keywords: Solid-State Transformers, AC/AC converters, Smart grids, Microgrids, Internet of Energy

The research is focused on power electronic conversion systems, such as Solid-State Transformers (SST), active nodes or active voltage regulators, for Medium and Low Voltage power distribution networks.

In such a scenario, a new isolated AC/AC conversion topology, denoted as *ROMatrix converter*, has been proposed in this research project. The novel structure has no DC stages and, therefore, the use of bulky electrolytic capacitors is avoided. This feature leads to better a MTBF compared to the other configurations. The *ROMatrix converter* has been designed to halve the voltage drops on the single power switch and, consequently, implement a Medium Voltage SST using the High Voltage *SiC* devices soon available on the market; at the same time, the number of switches is comparable to other AC/DC/AC configurations.

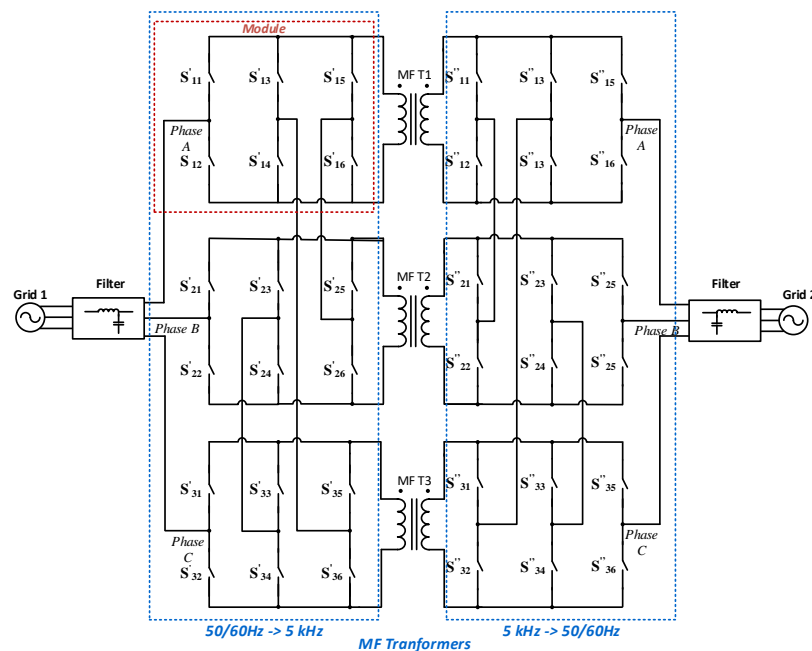


Fig. 1 - The ROMatrix Converter concept.

References

- [1] S. Pipolo, S. Bifaretti, A. Lidozzi, L. Solero, F. Crescimbinì and P. Zanchetta, "The ROMatrix Converter: Concept And Operation", *Proc. of IEEE 3rd Annual Southern Hemisphere Power Electronics Conference*, Dec 2017.
- [2] S. Pipolo, S. Bifaretti, A. Lidozzi, L. Solero, F. Crescimbinì and P. Zanchetta, "Power Control Capabilities of the Romatrix Converter", *Accepted for at IEEE Energy Conversion Congress and Exposition (ECCE) 2018*.

SENSORLESS CONTROL OF PERMANENT MAGNET MACHINE FOR HIGH EFFICIENCY VARIABLE SPEED PUMP-FAN APPLICATIONS

Keywords: Permanent magnet synchronous motors, Position-sensorless control, sensorless control, observer-based control.

The research topic is related to novel position and speed estimators, based on rigorous stability proof, which does not require the estimation of the stator fluxes and, thus, working directly with the sin/cos dynamics. Such observers can be used in combination to a very low-resolution (e.g. 1 PPR) speed measurement to implement a position-sensorless control. In order to achieve a full sensorless control, the rotor speed can be estimated by a Phase Locked Loop (PLL), based on a third-order Steady-State Linear Kalman Filter (SSLKF), employed to mitigate the estimated angle distortions as well. Such a technique allows in fact to obtain clean signals without introducing significant lags in order to preserve the control loop bandwidth. The main benefit of the proposed control are the following: 1) does not require an initial rotor alignment; 2) the sin/cos estimations are not directly affected by the stator resistance and machine input voltages; 3) sensitivity to current measurement noises is mitigated by the SSLKF-PLL.

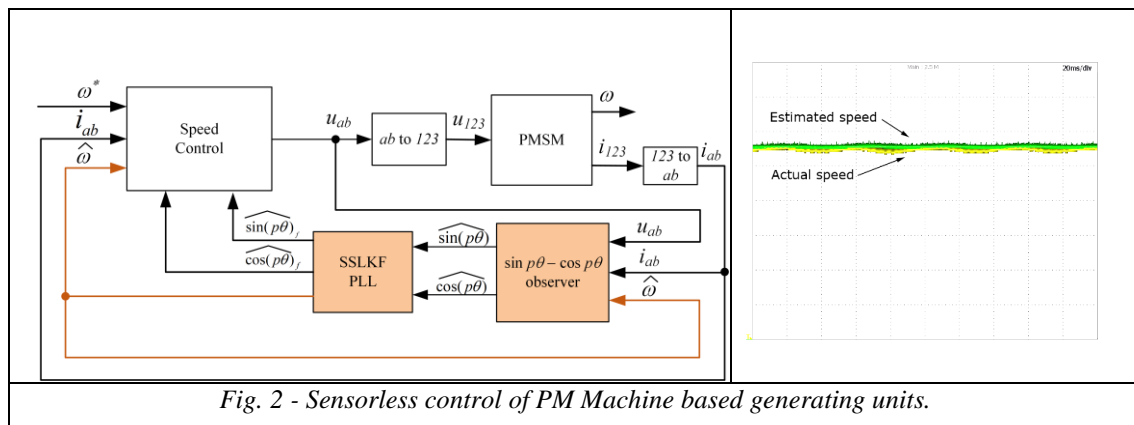


Fig. 2 - Sensorless control of PM Machine based generating units.

References

- [1] Verrelli CM, Bifaretti S, Carfagna E, Lidozzi A, Solero L, Crescimbinì F, "From Position-Sensorless to Sensorless Control of PM-Machine Based Generating Units." Submitted to *IEEE Transaction on Industry Applications*.
- [2] Verrelli CM, Bifaretti S, Lidozzi A, Solero L, Crescimbinì F, Sensorless control for PM-machine based generating units. *8th IEEE International Symposium on Sensorless Control for Electrical Drives (SLED 2017)*, Catania, Italy.
- [3] Bifaretti S, Lidozzi A, Solero L, Tiberti M, Tomei P, Verrelli CM. Position estimation for permanent magnets synchronous machines in pump-fan and generating applications. *7th IEEE International Symposium on Sensorless Control of Electrical Drives (SLED 2016)*, Dinarau, Nadi, FIJI, June 5-6, 2016.
- [4] Bifaretti S, Iacovone V, Rocchi A, Tomei P, Verrelli CM. Nonlinear speed tracking control for sensorless PMSMs with unknown load torque: from theory to practice. *Control Engineering Practice*, vol. 20, no. 7, pp.714-724, 2012.