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RESEARCH TOPICS

- Sensorless control for permanent magnet synchronous motor drives
- Energy Management System for series hybrid vehicle based on supercapacitor storage
- Inrush current in Cold Ironing applications

SENSORLESS CONTROL FOR PERMANENT MAGNET SYNCHRONOUS MOTOR DRIVES

Keywords: Sensorless control, PMSM, BEMF, current injection

The study focuses on the control of Permanent Magnet Synchronous Motors (PMSM) without using position transducer. PETRA Lab has already designed and implemented sensorless algorithms based on high frequency injection, working both at low and high speed. Recent studies focus on algorithms without current injection (which causes acoustic noise). The activity aims to extend the use of methods based on Back Electromotive Force (BEMF) in the low speed region, analysing the intrinsic limits of these controls. In particular, motor starting with different load type (i.e. idle, constant torque, viscous torque) was analysed, in order to determine in which industrial application the proposed controls can be used. Moreover, alternative algorithms to realize position control without current injection are under study.

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ENERGY MANAGEMENT SYSTEM FOR SERIES HYBRID VEHICLE BASED ON SUPERCAPACITOR STORAGE

Keywords: Energy efficiency, Fuel economy, Hybrid Electric Vehicles (HEV), Series architecture, Supercapacitors, Silicon Carbide (SiC).

The aim of the study is to analyse storage and power electronics innovations influence on medium size car hybrid powertrains. The use of supercapacitors as storage system together with Silicon Carbide power electronics guarantees high efficiency. This revaluates the series architecture, which nowadays is not employed in medium size car (as a matter of fact parallel architecture is used). Series architecture, despite it introduces additional electrical losses, allows Internal Combustion Engine optimal working condition. Simulative analysis were carried out which demonstrated that a properly sized supercapacitor storage is suitable for series hybrid vehicle application

and this configuration allows up to 40% fuel consumption reduction compared to parallel architecture. The study will continue with experimental tests on storage system (EDLC supercapacitor, Li-ion supercapacitor and Li-ion battery) in real working condition (i.e. fast and repetitive charges and discharges).

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INRUSH CURRENT IN COLD IRONING APPLICATIONS

Keywords: Inrush current, Cold Ironing, Multilevel converters

In this study the effects of the transformer inrush currents, in a real plant of 11 MVA, with 4 NPC converters in parallel, for cold ironing applications, are addressed. The first part of the activity was a collaboration with POSEICO S.p.A. aimed to develop their first NPC converter. This converter has a DC-link with a voltage equal to ±2.7 kV and a power equal to 3 MVA. Four of these converters were connected in parallel to feed 4 primaries of an output transformer for a cold ironing application in the harbour of Genova, feeding vessels at 50Hz or 60Hz. The converter powers a complex electrical network with the possibility to power a single MV (Medium Voltage) vessel or up to 10 LV (Low Voltage) vessels. One of the problems object of the present research is how to deal with the inrush current caused by the insertion of one transformer used to power a new LV vessel when another one is already powered by the converter, i.e., when it is not possible to turn off the converter and successively to turn on the converter itself, with all the transformers needed connected to it, with a V/f ramp, because in this way, all the vessels already powered by the converter would have a blackout fault.
In normal electrical networks, the power is given by an electromechanical generator that can support the transformer insertion inrush current without faults, may be with a transient decreased output voltage but without blackouts. Unfortunately, power electronics cannot deal with this kind of transients and would cause a fault that results in a global blackout fault.
The trivial solution is to “ask” the converter to connect a new transformer and decrease the output voltage by a 50% in order not to have the inrush current, for about 1s. In some cases, this solution can be acceptable but non optimal. The research deals with a control of the DC current component in each output phase of the converter in order to decrease the inrush current of the inserted transformer without affecting the already connected transformers feeding other LV vessels.

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