ICEM 2024, Torino, September 1-4 2024

Tutorial Proposal

TUTORIAL TITLE:

High-Performance Torque Controllers for Multi-Three-Phase Motor Drives

TUTORIAL PRESENTERS (Full Names, affiliation and e-mail addresses):

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BIOS OF THE PRESENTERS (150 words each):

Sandro Rubino (S’16, M’18) received the M.Sc. and Ph.D. degrees in Electrical Engineering from Politecnico di Torino, Torino, Italy, in 2014 and 2019, respectively. He is currently Assistant Professor with Dipartimento Energia “G. Ferraris,” Politecnico di Torino. He serves as a reviewer for some IEEE Transactions and international conferences. His main research interests include power electronics, modeling, and control of multiphase electrical machines and high-performance ac motor drives. Dr Rubino is an Associate Editor of IEEE Transactions on Industry Applications on behalf of the Industrial Drive Committee of the IEEE Industry Applications Society. He was the recipient of two paper awards from the Industrial Drives Committee of the IEEE Industry Applications Society and two Ph.D. thesis awards from the IEEE Power & Energy Society Italy Chapter and the IEEE Industrial Electronics Society Italy Chapter, respectively.

Radu Bojoi (SM’10, F’19) received the M.Sc. degree in electrical engineering from the Technical University of Iasi, Iasi, Romania, in 1993, and the Ph.D. degree in electrical engineering from the Politecnico di Torino, Turin, Italy, in 2002. He is currently a Full Professor of power electronics and electrical drives with the Energy Department “G. Ferraris” and the Chairman of the Power Electronics Innovation Center, Politecnico di Torino. He has authored or coauthored more than 200 papers covering electrical drives and power electronics for industrial applications, transportation electrification, power quality, and home appliances. Dr. Bojoi is the past Co-Editor-In-Chief of IEEE Transactions on Industrial Electronics. He was the recipient of seven IEEE paper awards. Dr. Bojoi is involved in many research projects with industry aiming at obtaining new products involving emerging technologies.

ABSTRACT (200 - 300 words):

Among the multiphase solutions, multi-three-phase motors are becoming more and more widespread in practice as the stator consists of multiple three-phase winding sets operating in parallel, thus allowing the use of conventional three-phase inverters to supply them modularly (see Fig. 1). This way, several advantages are obtained. For instance, the fault-tolerance capability is implemented according to the three-phase modularity, avoiding low-order harmonic content on the DC-link current and torque. Besides, power-sharing strategies can be implemented, resulting in useful for the series of parallel connections of the DC-links belonging to the three-phase units.

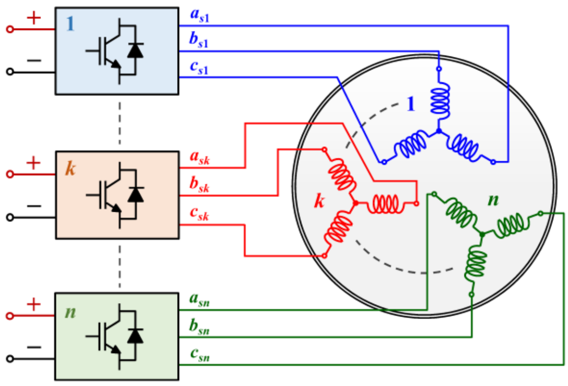

Fig. 1. View of a multi-three-phase drive topology.

The literature reports several modeling approaches to deal with multi-three-phase motors. Among these, the most recognized are in the order Vector Space Decomposition (VSD), Multi-Stator (MS), and the more recent Decoupled Multi-Stator (DMS). These approaches model a multi-three-phase motor differently, thus leading to several pros and cons that directly impact the advantages and drawbacks of torque controllers based on them.

According to this scenario, this tutorial will present strict methodologies for designing and implementing high-performance torque controllers for multi-three-phase drives. The guidelines for selecting the most suitable modeling approach from those previously mentioned will be reported, starting from the features required for the torque controller. Moreover, several control structures will be presented, focusing on those able to perform high-performance and accurate torque regulation in Flux Weakening (FW) operation with Maximum Torque per Volt (MTPV). Finally, experimental results validating the presented methodologies will be shown, considering a 12-phase induction- and 6-phase wound-field synchronous motor for aircraft and a 9-phase permanent magnet synchronous motor (PMSM) prototype.

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This tutorial will be organized into several sections as follows.

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    - Applications
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    - 6-phase WFSM as dual-three-phase (2x3-phase)
        - DMS-based DFVC
5) Future trends and conclusions