ERCIM "ALAIN BENSOUSSAN"
FELLOWSHIP PROGRAMME

ERCIM
European Research Consortium
for Informatics and Mathematics

Scientific Report

First name / Family name	Yu Wang
Nationality	Chinese
Name of the *Host Organisation*	Department of Electric Power Engineering, Norwegian University of Science and Technology
First Name / family name of the *Scientific Coordinator*	Olav Fosso
Period of the fellowship	01/12/2019 to 30/11/2020

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

(1) Doing the research mainly focus on the control strategy and stability analysis for power electronics system, especially for the dual-active-bridge high-frequency isolated bidirectional DC/DC converter.
(2) Explore academics and exchange ideas with Ph.D. students, colleagues and scientific coordinator in our research team.
(3) Summarize academic achievements and write journal and conference papers.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

(1) Title : An input-voltage-sharing control strategy of input-series-output-parallel isolated bidirectional DC/DC converter for DC distribution network
Authors: Yu Wang, Yuanpeng Guan, Olav Bjarte Fosso, Marta Molinas,Chen Zhang, Si-Zhe Chen and Yun Zhang
Abstract: Input-series-output-parallel (ISOP) isolated bidirectional DC/DC converter (IBDC) become a preferred scheme connecting high-voltage and low-

voltage bus in DC distribution network. Input-voltage-sharing (IVS) among modules is essential to realize the stable operation of ISOP system. Nowadays, with large-scale access of distributed energy sources and loads in DC grids, the fluctuations in bus voltage and connected load become frequent and great, deteriorating the IVS performance and stable operation of ISOP structure IBDC. To solve this issue, a triple-close-loop IVS strategy is proposed in this paper. Compared with conventional IVS strategy with constant input impedance, the proposed IVS strategy reshapes input impedance to be a full-order model containing high-order components and sensitive to fluctuation of output voltage, and IVS control based on reshaped impedance improves dynamics feature, maintains ideal output power and avoids false protection and potential instability for ISOP structure IBDC under frequent and large fluctuation. Experimental results verify correctness and effectiveness of the analysis and proposed strategy, providing a feasible,efficient and practical control scheme for ISOP system in DC distribution network.

Submit to: IEEE Transactions on Power Electronics
Submit Date: September 17, 2020

(2) Title : An modality analysis and tolerant methodology for open-circuit switching fault in dual-active-bridge DC/DC converter considering parasitic parameter

Authors: Yu Wang, Xiong Liu, Marta Molinas, Olav Bjarte Fosso, Wang Hu and Yuanpeng Guan

Abstract: Modality analysis is an effective method for open-circuit switching fault (OCSF) analysis in dual-active-bridge (DAB) converter. However, the power components are usually regarded as ideal components in OCSF analysis and do not satisfy actual requirement of modality analysis and control design for DAB. To solve this issue, modality analysis for OCSF in DAB converter considering parasitic parameters is investigated in this paper, and the sneak circuit and electrical quantity variation caused by parasitic parameters are comparatively discussed, improving the OCSF analysis system for DAB converter. Besides, to realize the fault tolerance for DAB during OCSF process, a fault tolerance strategy including modelling, topological transformation principle and practical control architecture are proposed. Compared with conventional fault tolerance strategy, the proposed strategy is convenient and efficient for DAB and its derivative converters during OCSF. The experimental results in DAB prototype verify correctness and effectiveness of proposed analysis and fault tolerance strategy for OCSF.

Submit to: IEEE Journal of Emerging and Selected Topics in Power Electronics
Submit Date: November 12, 2020

(3) Title : An eigenvalues analysis method for power grid stability based on discrete time domain model

Authors: Yu Wang, Olav Bjarte Fosso and Marta Molinas

Abstract: The eigenvalue analysis based on state space model is an important method to study stability of power grid. With the increased proportion of new energy sources and the increased power electronics in power grid, the

traditional state space construction method suffers from complicated process of determining state variables and large calculation amount of eigenvalues, and nonlinear stability characteristics of power grid cannot be accurately reflected. To obtain eigenvalues of power grid more efficiently, this paper proposes a method for constructing power grid state space based on discrete time domain model (DTDM) and present the corresponding stability criterion. Compared with traditional method, the nonlinear characteristics of components under proposed method can be linearized, and the constructed state space can capture a wider range of system information. Besides, the complete state space of system can be obtained only by the connection between component's DTDM and power grid. Moreover, because the eigenvalue solution under proposed method relies on the sparse grid node voltage matrix, the calculation of the eigenvalue is simple and efficient, and it can visually present variation trend of eigenvalue and investigate the stability of system. Simulation results in MATLAB verifies the correctness and effectiveness of proposed method.

Status: Plan to submit to IEEE Conference

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

Due to the Covid-19 pandemic and travel restrictions, most conferences were postpone or canceled nowadays, I do not attend conference during fellowship period. However, a conference paper "An eigenvalues analysis method for power grid stability based on discrete time domain model" has been written, and I will attend the conference virtually or actually after the Covid-19 pandemic in the future.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

Because of the Covid-19 pandemic and travel restrictions, I do not visit other ERCIM institutions.