Guest Editorial: Special Section on Protection and Control of Smart Grid with High Penetration of Converter Interfaced Generation Resources

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ELECTRICAL system characteristics are changing substantially as the penetration levels of renewable generation and in general converter interfaced generation resources (CIGRs) increase. The operation of these systems constitutes a challenge for the engineering in protection and control systems.

Part of the importance of CIGRs for the modern power systems lies in the integration of renewable energy sources into the conventional distribution system, reducing the environmental impact and emissions. With a proper protection and control systems coordination, it is possible to maximize the use and capacity of generation resources, increasing efficiency and reducing costs.

Based on the literature, is it notable that CIGRs alter the dynamics and the characteristics of the power grid at both transmission and distribution. Conventional systems in distribution networks have been designed assuming unidirectional flow. However, distributed resources affected this behavior. In addition to that, CIGRs present some characteristics such as lack of negative-/zero-sequence fault components, limited fault currents, unusual dynamics of the fault evolution, etc.

Based on the above, new protection and control approaches are required considering the existing limitations in conventional systems. The new systems must consider some impacts with the participation of CIGRs like the vulnerabilities due to the synchronization instability of inverters, lower inertia and fault characteristics, among others.

Modern power systems with CIGRs participation do not have a specific size or function, since the energy, economic and technical resources of each location are different, which is why the architectures, topologies, and power size vary significantly from project to project. For this reason, support the engineering from the research in topics as new protection and control schemes, become essential to improve some indicators like the reliability, resilience, and power quality.

Thirteen articles were included in this special section, which are summarized as follows.

In the paper entitled "Grid Forming Converters in Renewable Energy Sources Dominated Power Grid: Control Strategy, Stability, Application, and Challenges", the authors present an overview of the state of-the-art for grid forming control methods considering control structures, fault current limiting capability, stability, application prospects and future challenges.

In the paper entitled "Coordination Control of Power Flow Controller and Hybrid DC Circuit Breaker in MVDC Distribution Networks", the authors propose a coordination strategy to release the series-parallel power flow controller (SP-PFC) potential on fault protection, based on the cooperation of SP-PFC and DC circuit breaker (DCCB).

In the paper entitled "Phasor-domain Dynamic Model of Asymmetric Current Injection Controller for Converter-interfaced Generator", the authors present an asymmetric current injection controller model for converter-interfaced generators to be used in fundamental-frequency three-phase root-mean-square (RMS) dynamic simulation tools.

In the paper entitled "Model Predictive Direct Power Control of Grid-connected Converters Considering Unbalanced Filter Inductance and Grid Conditions", the authors propose a direct power control predictive model for the grid-connected converters considering unbalanced filter inductance and grid conditions.

In the paper entitled "Power Quality Improvement for Grid-connected PV System Based on Distribution Static Compensator with Fuzzy Logic Controller and UVT/ADALINE-based Least Mean Square Controller", the authors propose a three-phase four-wire grid-integrated PV system employing distribution static compensator (DSTATCOM) and considering different power quality tasks.

In the paper entitled "A Grid-tied PV Inverter with Sag-severity-independent Low-voltage Ride Through, Reactive Power Support, and Islanding Protection", the authors propose a grid-tied photovoltaic (PV) inverter with anti-islanding protection, that simultaneously supports the low-voltage-ride-through (LVRT), and the reactive power.

In the paper entitled "Fault Diagnosis with Wavelet Packet Transform and Principal Component Analysis for Multi-terminal Hybrid HVDC Network", the authors make a review of fault diagnosis and propose an algorithm to improve the fault detection ability of high-voltage direct current (HVDC) systems, considering the wavelet packet transform and principal components analysis to the inverter-side fault diagnosis.

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In the paper entitled "Impedance Modeling and Stability Factor Assessment of Grid-connected Converters Based on Linear Active Disturbance Rejection Control", the authors establish the equivalent impedance and coupling admittance models of a typical three-phase converter during weak grid condition, where the linear active disturbance rejection control (LADRC) is used into the DC-link voltage control. Key factors on the system stability and frequency coupling effects are presented in this paper.

In the paper entitled "Non-permanent Pole-to-pole Fault Restoration Strategy for Flexible DC Distribution Network", the authors propose a fault recovery scheme based on local information for pole-pole faults on DC distribution networks, using wavelet analysis for fault detection and considering single-ended measurements.

In the paper entitled "Cross-seam Hybrid MTDC System for Integration and Delivery of Large-scale Renewable Energy", the authors propose a hybrid multi-terminal high-voltage direct current (MTDC) transmission system to increase the utilization and penetration of renewable energies in the USA.

In the paper entitled "A VSC-based Model for Power Flow Assessment of Multi-terminal VSC-HVDC Transmission Systems", the authors make a comprehensive and flexible model of a voltage source converter (VSC) suitable for power flow studies in multi-terminal VSC-based high-voltage direct current (VSC-HVDC) systems.

In the paper entitled "Analysis and Control of Modular Multi-terminal DC Power Flow Controller with Fault Current Limiting Function", the authors propose a modular multi-terminal DC power flow controller (MM-DCPFC) with fault current limiting function in order to overcome the problems of power flow control and fault current limiting in MTDC grids.

Finally, in the paper entitled "High-performance and Multi-functional Control of Transformerless Single-phase Smart Inverter for Grid-connected PV System", the authors present an energy-based single-phase voltage-source smart inverter (SPV-SSI), successfully designed, analyzed, and validated.

We would like to thank all participating authors for submitting their works to this special section. We are thankful to the guest editors listed below and reviewers for the selection of all the articles considered for this special section in a most efficient and efficacious manner.

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