

MMC energy limits estimator

Real-time calculation of available energy

CONTEXT

The Modular Multilevel Converter (MMC) is considered as the most promising converter technology for HVDC applications. The topology of the MMC is comprised of thousands of distributed sub-module (SM) capacitors which behave as energy storage devices. This distinct feature of the MMC brings an additionnal degree of freedom - the internally stored energy - which does not exist in conventional Voltage Source Converters (VSCs). In order to ensure the proper function of the MMC, this energy must be maintained within a certain range. This range varies in accordance with the operating power and the associated grid conditions. Knowing the upper and lower limits of the energy is important for maintaining adequate margins from the present level of the energy. However, due to the complexity of the internal dynamics of the MMC, it has never been clarified.

TECHNOLOGY DESCRIPTION

From in-depth analysis on the internal energy pulsations, which cause the SM capacitor voltage ripple, we developed a control module, named the Energy Limits Estimator. This module can perform a realtime calculation of the absolute upper and lower limits of the energy in the MMC taking into account the associated grid conditions, the power set points, the number of the available SMs, etc. As long as the internal energy level stays within the calculated limits, the secure operation of the MMC is ensured. This module can be integrated to the local converter control to prevent over-modulation of the MMC and excess SM capacitor voltages. Moreover, by setting the operating level of the energy according to the calculated limits, the security margin can be maximized.



APPLICATION DOMAIN

MMC control Point to point HVDC connection MTDC grids Virtual Capacitor Control

ADVANTAGES



Easy Implementation





Failure Avoidance

Higher security

Optimal Operation





Extended operational Submodule capacitor limits (P,Q)

downsizing

TRL SCALE

5 6 1 2 3 4 7 8 9 Control strategy tested on small scale MMC

DELIVERABLES

Patent FR3053854 (B1) WO2018007741 (A1) Control software implementations Virtual mock-ups Technical reports Training, technical support

SCIENTIFIC REFERENCE

Shinoda, K., Benchaib, A., Dai, J., & Guillaud, X. (2018). Analysis of the lower limit of allowable energy in modular multilevel converters. In 2018 20th European Conference on Power Electronics and Applications (EPE'18 ECCE Europe)



Shaping power transmission

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