

Study Committee B4

DC Systems and Power Electronics

Paper 211_2022

Novel HVDC MMC VSC Topology with DC Fault Current Limiting Capability

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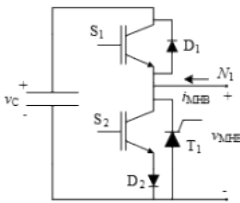
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Motivation

- Modular multilevel converters (MMCs) have become the de-facto topology for VSC-HVDC systems
- MMCs with the commonly used half-bridge submodule (SM) do not have the ability to block dc faults
- Alternative converter topologies with inherent dc-fault blocking capability are desirable

Method/Approach

- An alternative SM topology (shown below) is proposed



- The proposed SM's behavior is investigated via detailed simulations in LT-Spice, EMT simulations in PSCAD/EMTDC, and a scaled-down laboratory prototype

Notable changes with respect to the original HB SM:

Thyristor T1 replaces the anti-parallel diode of lower IGBT

Diode D2 is added in series with S2 to allow the SM to withstand negative voltage

Operating States:

ON state: S1 is triggered (current flows through either D1 or S1)

Bypass (Off) state: S2 and T1 triggered (current flow through S2 and D2 if it is positive; current flows through T1 if it is negative)

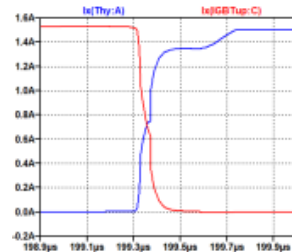
Blocked state: No trigger signal to S1, S2 and T1

Objects of investigation

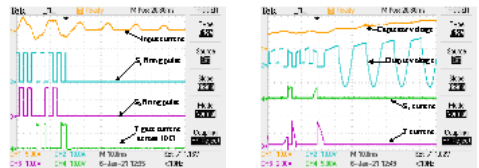
- The objective of the study is to determine, via simulations and experiments, the operating merits and limitations of the proposed MHB
- Simulation in LT-Spice consider the physics of the semiconductor devices
- Simulation in PSCAD/EMTDC reveal the SM-level dynamics in the context of a converter in a wider system
- Experimental results show the implementation details of the SM (at a scaled down level)

Experimental setup & test results

- Sample of LT-Spice simulation results

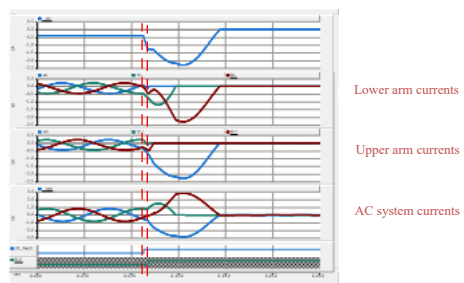


- Sample of experimental results



IGBT1 and Thyristor current and voltage - Prototype

- Sample of PSCAD/EMTDC results



Discussion

- The results obtained confirm the operation of the MHB SM
- Further validation at higher ratings is required

Conclusion

- The proposed MHB SM is a promising alternative to the conventional HB SM
- It offers dc-fault blocking capability and is minimally more complex than the conventional HB SM