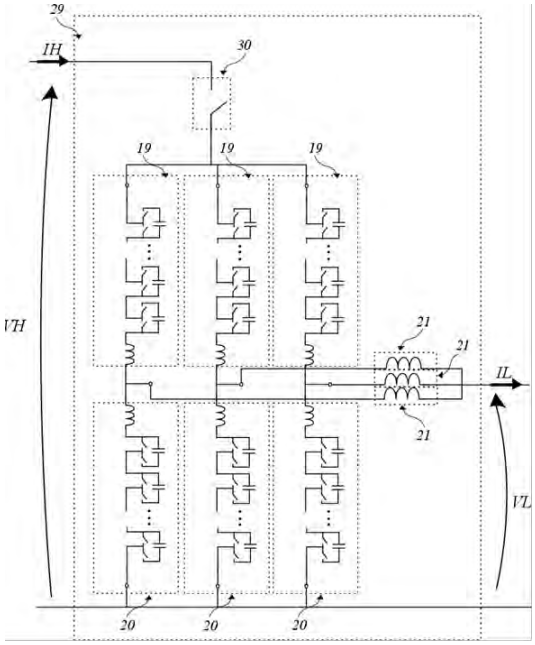
DC-MMC with fault-blocking capability

CONTEXT

DC/DC converters are key elements for future multi-terminal dc systems. They are expected to provide power flow control between two HVDC point-to-point links or grids. When a fault occurs on one side, the other grid should remain in operation. This feature is named here “fault blocking capability”. For some topologies like non-isolated DC-MMC, this feature can be obtained by increasing the number of submodules and the energy stored in the converter. This leads to an overcost and a over size.



TECHNOLOGY DESCRIPTION

When a fault occurs in the low voltage (LV) grid, to avoid fault propagation, the DC MMC should include a number of SM in upper arms large enough to withstand the rated voltage of the high voltage (HV) grid. In some cases, the fault blocking capability comes with an oversizing of the upper arms. Otherwise, a DC circuit breaker (DCCB) will be needed. The proposed solution consists in controlling the converter to make the HV current going to zero and using a switch. As the current to break is almost zero, the switch cost will be reduced compared to a DCCB. With the proposed control, the upper arm current is controlled with the lower arms thanks to the energy stored in the SM capacitors. The lower arms overcurrent is prevented thanks to the output filtering inductances. The sizing of the inductances and capacitors could be as well designed accordingly to switch opening time of the available technology. Finally the number of SM is significantly reduced.

APPLICATION DOMAIN

- HVDC multiterminal systems

ADVANTAGES

Provide fault blocking capability for the DC MMC without increasing the number of SM in the upper arms

TRL SCALE

1 2 3 4 5 6 7 8 9

Concept validated with simulations

DELIVERABLES

Patent application FR1915048, filling date: dec 20th 2019

Report

Simulation files

SCIENTIFIC REFERENCES

HVDC Converters for the interconnection of HVDC grids, Juan Paez, PhD thesis, Dec 2019.

Overview of DC–DC Converters Dedicated to HVdc Grids, Juan Paez et al., IEEE Transactions on Power Delivery, 2019

Impact of DC fault blocking capability on the sizing of the DC-DC Modular Multilevel Converter, Juan Paez et al., IEEE EPE 2020 (to be published)