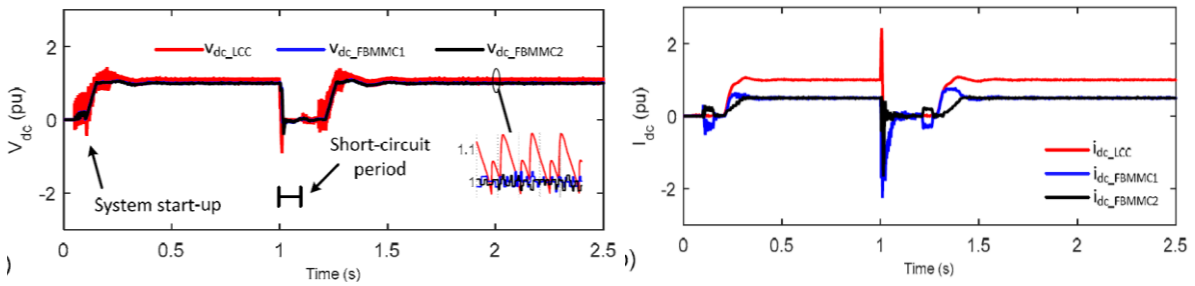
VSC topologies and DC fault handling issues

1 – Introduction

Considering the topology of the Half-Bridge converter, when a DC fault happens the DC current is fed by the diodes in an uncontrolled way. So, the only way to interrupt the DC fault current is open the AC circuit Breakers (rectifier and inverter). After deionization time, these AC breakers must be reclosed to the DC system restoration. Considering these actions the DC system can resume a long time to the full power restoration. For example, the maritime VSC-HVDC link (500 MW-Bipolar) can resume about 700 ms to the full restoration after the DC fault happens [1].

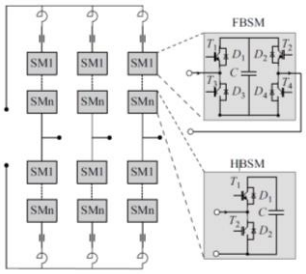
The full-bridge topology has wide operating flexibility. It can control the DC voltage in both positive and negative polarity. This characteristic can be fully applied to control the DC fault current faster than the Half-bridge like the LCC forced retard action. One example of the feasibility of applying Full-Bridge to control the short-circuit DC current is shown below [2].



The Hybrid HVDC system was restored in 400 ms and it can be faster or slower depending on the system requirements.
Not only considering its intrinsic DC fault handling, the full-bridge can guarantee AC voltage control even during DC short-circuit (operation as a huge STATCOM).

The full-bridge converter is considered an expensive solution yet and its losses are high.

Another converter topology (Hybrid converter) that is comprised of Full and Half-Bridge submodules in series configuration has been studied and was applied in WDD Project (Hybrid HVDC) [2]. A hybrid converter can take the same advantages as Full-bridge with lesser loss and cost, but some issues like Reduced DC voltage operation, generation of the AC and DC voltages, and the DC fault current handling have to be considered to determine the ratio of Full and Half-bridge [3];



2 – Conclusions

Based on all the contents described here, we can conclude:

- When the spent time to recover the system after a DC fault is not important, opening and reclosing breaker action can be considered (Half-Bridge);
- Half-Bridge is a great solution for VSC-HVDC transmission systems with no DC short-circuit problems;
- Not only considering the DC fault handling issue, the full-bridge will also give more operating flexibility for the HVDC system;
- Hybrid converter topology (%FB + %HB) is the cheapest solution having the same advantages as Full-bridge;
- In [3] the LCC-VSC MTDC system was restored about 400 - 420 ms;

3 – References

[1] Maritime Link - The First Bipolar VSC HVDC with Overhead Line - 2019 AEIT HVDC International Conference (AEIT HVDC)

[2] J. R. Lebre et al. “Hybrid HVDC (H2VDC) System Using Current and Voltage Source Converters”, Energies
https://www.mdpi.com/1996-1073/11/6/1323

[3] Key Technologies of Ultra-high Voltage Hybrid LCC-VSC MTDC Systems - CSEE JOURNAL OF POWER AND ENERGY SYSTEMS, VOL. 5, NO. 3, SEPTEMBER 2019