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Detection of Fault in MMC HVDC System Using a Simplified Transmission Line-A Review

Miss. A.C. Lawhale[1] and Dr. M.V. Jape[2]

Student[1], Govt. College of Engineering Amravati
Professor[2], Govt. College of Engineering Amravati

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ABSTRACT
Multi-terminal adaptive HVDC arrays are important because they maximize the use of sustainable power supplies. However, these sources may be liable. A fast and selective protection circuit is absolutely essential to ensure continuous operation and high reliability. In case of DC link failure in HVDC system based on Modular Multi-Level Converters (MMCs), this article focuses on transient voltages. Then, at this point, we propose a fast, non-unit insurance scheme for the AC line, taking into account transient voltage shortfalls using the limiting effect of the current-limiting reactor. MATLAB is used to simulate MMC based 4-terminal HVDC networks and runs extensive simulations to assess the scheme's performance. The simulation results demonstrate that the suggested protection mechanism efficiently and precisely detects high-resistance problems.

I. INTRODUCTION

The fastest-growing electrical energy source in recent years is photovoltaic energy conversion systems that are grid-connected (in just five years, from 10 to 100GW)[1]. Currently, the corresponding amount of wind power in solar energy is 35% but more quickly, headed in the same way as wind power in terms of becoming a big participant in some localised power markets. The main force behind this development is the decline in the price of photovoltaic modules, which has opened the way for utility-scale or large-scale photovoltaic plants. The majority of developments in converter designs for solar frameworks (housetop and small photovoltaic plants)focus on small and medium scale frameworks socalled string and multi-string inverter arrangements[2]-[3]. In any case, the main way to communicate enormous scope photovoltaic plants is through the example of a two-level voltage source inverter, sometimes referred to as a focal inverter[1]. The voltage on the dc side below 1000 V limits the low voltage at which the central inverter operates because of the insulation limitations of the photovoltaic modules. This requires a voltage step-up transformer, either one or two phases. Galvanic isolation is another feature that this DC stage might offer to keep users away from low-frequency transformers. Two more options are depicted in the figure a dc system with two transformers, one each for high- and low-frequency operation1.It is also possible tocombine different designs in one photovoltaicranch, especially if they are shipped in different phases. Staggered converter geographies have been proposed to organize network-associated potovoltaic setups, which, in order to get around the dc side's low voltage restriction, are circulated the DCside but coupled to the medium voltage alternating current frameworks[4]-[16]. Because there are so many DC interface associations that are accessible and allow for different individual string MPPT associations, the flowed H-Span in particular has received a lot of attention[11]-[16]. While operating as central inverters, these multilevel ac-grid inverters also have multistring or string capabilities on the dc side. A promising area of research for large scale AC network photovoltaic systems, they introduce medium voltage operation, enhance power quality, are more efficient, and use fewer filters. In some of the best solar radiation areas far from areas of consumption, such as the deserts of Chile, Australia and Middle Eastern countries, large-scale photovoltaic could be profitable. The best locations for solar radiation and primary consumption centers across oceans are also cities (on the mainland) and islands in Greece, as well as throughout Europe and North Africa. HVDC transmission is the best choice for long overhead lines (more than 400 km) or underground links (more than 70 km). The DC-AC power station is the same as in the figure.1 followed by a DC HVDC Air conditioning station which is required to communicate with a extensive voltage plant from such a outside location to large consumer site using current technology. Another concept, where two phases are combined into a single HVDC photovoltaic power plants, will be considered in this article.For voltage integration at lower levels, a single-phase arm of the same Modular Multi-Level Converter (MMC) used for the HVDC (without reactor) has been modified with extra DC to DC stages. string or multiple string order[17]. This concept is not only putting a single MPPT at the heart of the system, but also greatly reduces the number of power converters, control platform, power filters and transformers. It should be noted that MMC technology is currently using more than 200 series modules to achieved high voltages and large-scale pressure power plant with a capacity of about 250MW are currently using more than 200 medium frequency inverters and DC-AC center. Moreover, the photovoltaic systems have continuous nature the proposed idea is simple modular and reliable. HVDC trunks can be used to connect multiple frames in case of extremely large-scale organization, i.e. For some high voltage installations, thanks to the multiport capabilities of the MMC based HVDC chassis. In this article, different potential circuit topologies are discussed and analyzed. With the corresponding control schemes. the simulation results of a small-scale MMC photovoltaic installation with 20 series inverters and PV module series are presented. The proposed circuit inherits several technical challenges related to high-voltage operation, particularly voltage isolation, despite its benefits and conceptual simplicity. This article discusses and analyzes several potential power circuit topologies. Simulation results for acompact MMC photovoltaic plant with 20 series inverters and potovoltaic module strings are provided along with corresponding control diagrams. Despite its advantages and conceptual simplicity,theproposed circuit inherits some technical difficulties related to high voltage operation, especially voltage isolation.

II. LITERATURE REVIEW

1.Multi-Terminal DC Framework: Challenges and Opportunities Just as AC power systems gradually evolve from simple structures to eventually complex systems, Rodriguez and Rousebech's 2017 MTDC system will evolve organically over time. grow up MTDC networks can be easily realized by tightly combining AC and DC.

2. Improved testing and control of his HVDC frame based on hybrid MMC in unbalanced DC voltage. defect. Jianpo Zhang, Chengyong Zhao 2017 Regulatory numbers have been cut in half, and continuous extraction technology has moved away from his contrasting traditional DVCC. The capacitor voltage balancing strategy for HVDC systems has also been improved.

3. Asymmetrical fuses for HVDC networks with inductive DC link terminals. Willem Leterme, Jef Beerten, Dirk Van Hertem 2016 Uneven protections schemes for hard-wired HVDC networks use voltage magnitude and derivative to difference forward and reverse faults, and current derivative to differentiate inversely distinguish the forward and reverse errors. In 2015, Guangfu Tang, Zhiyuan He, Hui Pang, Xiaoming Huang and Xiao-Ping Zhang demonstrated that voltage levels above 200 KV can be used to build their regional HVDC VSC-based DC networks. The experience gained in planning, creating and building the Zhoushan DC Power Framework will be a special reference for improving and using this innovation worldwide.

4.Moving wave-based techniques for fault identification in long-range DC systems Adegh Azizi, Majid Sanaye Pasand Abbas Hassani 2014 Supplementary. The disconnect phase defines a graph that represents the current geographical location of the organization. The proposed techniques can be effectively applied to any MTDC frame with an unequal mix of the above connections and mixed DC lines.

5. MMC HVDC Fig1. showa diagram of the MT-MMC HVDC framework under several potential scenarios presented in the ocean event and ocean data of the UK Public Grid (ODIS) [6]. The framework's reference circuit boundaries are based on data provided in its ODIS to map a typical Cycle 3 wind farm in the UK. In the appendix is a table with the most important system settings. 2.1. MMC The basic part of the MMC HVDC chassis is the converter. There are several types of MMCs including but not limited to Alternate Arm Adapter (AAC), Global (FB), Half-bridge (HB) [7]. FB-MMC and AAC are known as error blocking converters because they can prevent current from flowing through the converter when there is a fault on the DC side. sThis is especially useful for HVDC systems using overhead lines. On the other hand, for a wired HVDC network, the fault on the DC side can be permanent, so the need for a fail-preventing converter remains unclear.HB-MMC is the only type of MMC available in the market. This article will focus on his HB-MMC, as underground cables dominate his proposed MTDC system.

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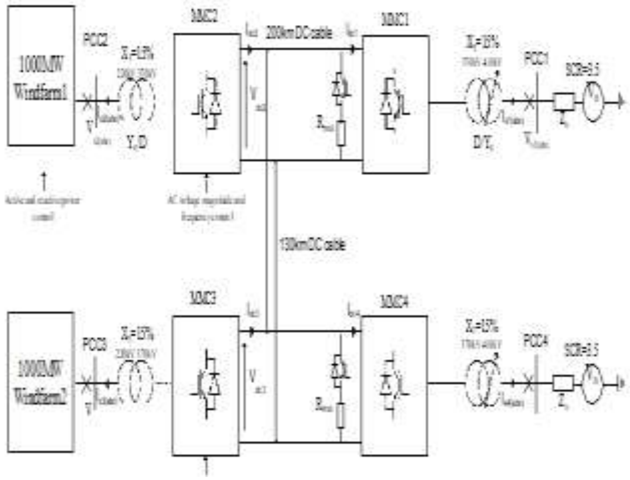

FIG1: MT MMC-HVDC SYSTEMMODEL

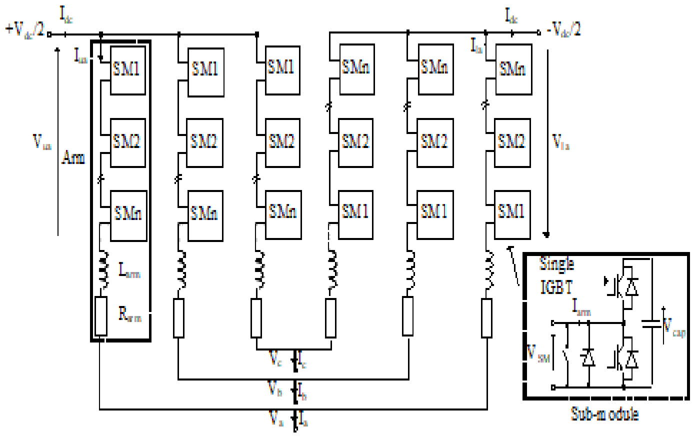

FIG2: THREEPHASE HB-MMC

The Vcap voltage on the LED capacitor and the Vcap voltage on the LED while the lower IGBT is off and the top IGBT is on are nearly equal.Depending on the flow of the passive current, capacitors may charge or discharge. The SM capacitor is disregarded while the lower IGBT is on and the upper IGBT is off, essentially maintaining VSM at zero voltage. As a result, each converter leg functions as a controlled voltage source, with the voltage across the stepper motor capacitor serving as the voltage with the least change in voltage. The voltage variations Vu(a,b,c) and Vl(a,b,c) of the upper and lower arms, respectively, limit the converter's actual output voltage, which is denoted by the letters A, B, and C. For case (1), repeat step A (8 times). The quantity of SMs in the converter arm determines how many discrete voltage levels an MMC may produce. The consonant portion of the received waveform is reduced as the number of SMs increases, but this also lowers the computational efficiency of the MMC converter model. There are numerous SMs per converter arm in the business MMC HVDC scheme[9]. While fewer SMs can be used and no AC filter is needed, the main reason for having so many SMs in each pin of the converter is to reduce the voltage stress on each SM. to limit it to a few kv for Determining the number of levels for a demonstrated converter therefore usually depends on the difference between the structure of the resulting waveform and the computational power of the model. In our study, we found that a 31-level MMC could adequately divide the difference by meeting the IEEE519 consonant voltage limit, essentially without compromising playback time. SM capacitance estimates the determining of CSM is a compromise between the capacitor SM overvoltage and capacitor size. A capacitance estimates that results in an SM voltage rise in the range of ±5% can be considered a reasonable compromise[10]. According to[10], the converter power can achieve 10% (5%) ripple voltage with 30-40 KJ of stored energy per MVA. Alternatively, the analytical strategy of Marquart et al. can be used. An approximate figure of the SM power needed to achieve a ripple voltage that is acceptable for a particular converter power can be determined using[11]. The current in the transformer branch consists of the three primary windings given in stage A condition (2). The flowing current circuit is due to the inconsistent DC voltages generated by the three transformer branches. Arm currents are distorted by circulating currents, anti-sequence currents (a-c-b) with twice the fundamental frequency, increasing converter losses[12]. The accessory reactors (also called converter reactors and arm reactors) with noise in Fig 2 have two main functions. The first is to reduce the effects of internal and external errors in the converter and the second is to reduce the circulating current between the arms of the converter. A circulating current can be achieved by properly dimensioning the attached reactor.

III. CONCLUSION

This article reviewed the most recent developments in modular multi-level converters by discussing the latest modular multi-level current and voltage source converter topology. The concept of modularity has been studied across different families of modular converters, from the cellular to the system level Using the recommended module concept. various modular converter topology were synthesized and classified. The double concept has also been utilized to create new modular current source topologies.A comprehensive comparison of topologies with high power application criteria was presented for each type of module converter, followed by general trends and challenges in the field. Due to the advancement of power semiconductor devices,as well as new standards and requirements, the technology of modular multi-level converters will certainly be developed and shaped in the future.

REFERENCES

[1] T. An et al., “A DC grid benchmark model for studies of interconnection of power systems,” CSEE Journal of Power and Energy Systems, vol. 1, no. 4, pp. 101-109, Dec. 2015.
[2] J. Liu, N. L. Tai and C. J. Fan, “Transient-Voltage-Based Protection Scheme for DC Line Faults in the Multi-terminal VSC-HVDC System,” IEEE Trans. Power Del., vol. 32, no. 3, pp. 1483-1494, Jun. 2017.
[3] T. An, G. Tang, and W. Wang, “Research and application on multi-terminal and DC grids based on VSC-HVDC technology in China,” IET High Voltage, vol. 2, no. 1, pp. 1-10, 2017.
[4] L. Z. Yao, J. Wu, L. Xu and M. H. Rahman, “Studies of coordinated zone protection strategy for DC grid,” in Power Electronics & Motion Control Conference, pp. 713-718, 2016.
[5] W. Su, Y. F. Gong and Y. Li, “Traveling-Wave-Based Line Fault Location in Star-Connected Multi-terminal HVDC Systems,” IEEE Trans. Power Del., vol. 27, no. 4, pp. 2286-2294, Jan. 2018.
[6] Q. Z. Lin, G. M. Luo, J. H. He, “Travelling-wave-based method for fault location in multi-terminal DC networks,” The Journal of Engineering, vol. 2017, no. 13, 2017.
[7] OMKK Nanayakkara, AD Rajapaks and R Wachal, “Location of dc line faults in conventional HVDC systems with segments of cables and overhead lines using terminal measurements,” IEEE Trans. Power Del., vol. 27, no. 1, pp. 279-288, Nov. 2012.
[8] M Kong, X Pei, H Pang, J Yang, X Dong et al., “A lifting wavelet-based protection strategy against DC line faults for Zhangbei HVDC Grid in China,” in European Conference on Power Electronics and Applications, pp. 1-11, 2017.
[9] D Yu, Y Li, Y Ding and X Zhang, “Fault Detection and Location for MTDC Combining Wavelet Analysis and Travelling Wave,” in Power Engineering & Automation Conference, Sept. 2012.
[10] FV Lopes, “Settings-free traveling-wave-based earth fault location using unsynchronized two-terminal data,” IEEE Trans. Power Del., vol. 31, no. 5, pp. 2296-2298, Apr. 2016.
[11] J. Suonan, G. Song, and Q. Xu, “Time-domain fault location for parallel transmission lines using unsynchronized currents,” Elect. Power Energy Syst., vol. 28, no. 4, pp. 253–260, 2006.
[12] J Suonan, S Gao, G Song, Z Jiao and X Kang, “A Novel Fault-Location Method for HVDC Transmission,” IEEE Trans. Power Del., vol. 25, no. 2, pp. 1203-1209, Apr. 2010.
[13] BJ Rui, VA Lacerda, RM Monaro et al., “Selective non-unit Protection Technique for Multi terminal VSC-HVDC Grids,” IEEE Trans. Power Del., pp. 1-1, Sept. 2017.
[14] M Farshad, J Sadeh. “A novel fault-location method for HVDC transmission lines based on similarity measure of voltage signals,” IEEE Trans. Power Del., vol. 28, no. 4, pp. 2483-2490, Jul. 2013.
[15] ZY He, K Liao, XP Li et al., “Natural Frequency-Based Line Fault Location in

HVDC Lines," IEEE Trans. Power Del., vol. 29, no. 2, pp. 851-859, Apr. 2014.

[16] G. Song, J. Suonan, and Q. Xu, "Parallel transmission lines fault location algorithm based on differential component net," IEEE Trans. Power Del., vol. 20, no. 4, pp. 2396–2406, Oct. 2005.

[17] S Azizi, M Sanaye-Pasand, M Abedini and A Hasani, "A Traveling-Wave-Based Methodology for Wide-Area Fault Location in Multi-terminal DC Systems," IEEE Trans. Power Del., vol. 29, no. 6, pp. 2552-2560, Dec. 2014.

[18] R. D. Shultz and R. F. Gonzales, "Operating characteristics of an HVDC multi-terminal transmission line under single-pole faulted conditions and high resistance earth return," Elect. Power Syst. Res., vol. 10, no. 2, pp. 103–111, 1986.

[19] J. Xu, C. Zhao, Y. Xiong, C. Li, Y. Ji and T. An, "Optimal Design of MMC Levels for Electromagnetic Transient Studies of MMC-HVDC," IEEE Trans. Power Del, vol. 31, no. 4, pp. 1663-1672, Aug. 2016.

[20] L. Tang and B.-T. Ooi, "Locating and isolating DC faults in multi-terminal DC system," IEEE Trans. Power Del., 2007, vol.22, no. 3, pp.1877-1884.

[21] F Kong, Z Hao, S Zhang and B Zhang, "Development of a novel protection device for bipolar HVDC transmission lines," IEEE Trans. Power Del., vol. 29, no. 5, pp. 2270-2278, Oct. 2014.

[22] J. P. Zhou, C. Y. Zhao et al, "Pilot Protection Method for DC Lines Based on Included Angle Cosine of Fault Current Component," Automation of Electric Power Systems, vol 42, no 14, pp 165-171, Jul. 25, 2018.

[23] J Yang, JE Fletcher and J O'Reilly. "Short-Circuit and Ground Fault Analyses and Location in VSC-Based DC Network Cables," IEEE Trans. Ind. Elec., vol. 59, no. 10, pp. 3827-3837, Oct.2012.