International Journal of Applied Power Engineering (IJAPE)
Vol. 15, No. 1, March 2026, pp. 289~297
ISSN: 2252-8792, DOI: 10.11591/ijape.v15.i1.pp289-297

Simulation of three phase grid interconnections with HVDC link with three level MMC converter

Madhubabu Thiruveedula, Nenavath Ramesh Babu, Penagonda Akash, Guthula Sravya Bhavana, Devasoth Arjun, Gavvala Chethan
Department of Electrical and Electronics Engineering, Teegala Krishna Reddy Engineering College, Hyderabad, India

Article Info

Article history:

Received Jan 4, 2025
Revised Nov 15, 2025
Accepted Jan 9, 2026

Keywords:

Grid interconnection
Harmonic performance
HVDC transmission
Modular multilevel converter
Voltage regulation
Voltage waveform control

ABSTRACT

This paper presents the simulation and analysis of a three-phase grid interconnection system using a high voltage direct current (HVDC) link with a three-level modular multilevel converter (MMC). The HVDC link enhances modern power transmission by reducing losses, increasing transfer capacity, and improving grid stability. The three-level MMC, known for its modular design, scalability, and low harmonic distortion, is employed for efficient grid integration. The system, modeled in MATLAB/Simulink, includes a three-phase alternating current (AC) grid, HVDC link, and MMC operating in both rectification and inversion modes to enable bidirectional power transfer. Proportional-integral (PI) controllers synchronize the MMC with the grid, ensuring stable operation under varying conditions such as load changes and disturbances. Simulation results indicate high efficiency, low harmonic distortion, reduced switching losses, and decreased voltage stress on components. The HVDC link also improves reliability by damping power oscillations and providing reactive power support. Overall, the integration of HVDC and MMC offers a robust, efficient, and sustainable solution for future high-performance grid interconnections, serving as a strong basis for further advancements in HVDC transmission systems.

Corresponding Author:

Madhubabu Thiruveedula
Department of Electrical and Electronics Engineering, Teegala Krishna Reddy Engineering College
Medbowli, Meerpet, Saroornagar, Hyderabad–500097, Telangana, India
Email: madhumk448@gmail.com

1. INTRODUCTION

The increasing global demand for electricity, combined with the growing complexity of power systems, has led to the exploration of advanced technologies for efficient power transmission. One of the most significant innovations in systems that transmit power is the high voltage direct current (HVDC) link, particularly when coupled with a modular multilevel converter (MMC) [1]. Compared to conventional alternating current (AC) systems, HVDC transmission has a number of benefits, including as increased efficiency, reduced losses, and the capacity to send electricity across vast distances with little voltage drop [2]. The integration of HVDC links with MMCs enhances the overall performance, enabling scalable and flexible grid interconnections that can meet the needs of modern electrical grids [3]. HVDC transmission systems are critical in modern power networks due to their ability to provide long-distance, high-capacity transmission with minimal losses [4]. Unlike traditional AC systems, HVDC systems do not suffer from the reactive power losses associated with AC transmission, and they also eliminate the need for synchronization between different power grids. These characteristics make HVDC systems particularly beneficial for applications such as offshore wind farms, undersea cable connections, and long-distance power transmission [5].

HVDC systems typically consist of two main components: the converter stations and the transmission line. The stations for conversion, which are linked to both the sending and receiving ends of the transmission line, convert AC power to DC power and vice versa [6]. HVDC systems are also equipped with various control mechanisms to regulate power flow, stabilize the grid, and ensure that power is delivered reliably [7]. One of the key benefits of HVDC is its ability to enable power transfer between asynchronously operated grids. This makes HVDC systems a valuable tool for linking different power grids that operate at different frequencies or are separated by large geographical distances [8]. By decoupling the grid frequencies, HVDC transmission allows for better control over power flow, ensuring that power can be efficiently transmitted from areas of high generation to areas of high demand [9].

The increasing global demand for efficient, long-distance power transmission has highlighted the restrictions of traditional AC transmission systems, especially for the transmission of power in bulk and grid interconnections across enormous distances. The technique known as HVDC has become an effective solution, known for its ability to transmit large amounts of power with minimal losses and enhanced stability over long distances [10]. HVDC systems are especially advantageous in applications such as submarine power transmission, asynchronous grid interconnections, and renewable energy integration, where AC systems face operational and stability challenges [11]. MMCs, or modular multilevel converters, are now a revolutionary advancement in HVDC transmission. Introduced as a scalable, modular solution, MMCs allow for high power and high voltage applications by assembling numerous sub-modules in series to achieve the necessary output voltage [12]. MMC technology not only provides superior voltage scalability but also reduces harmonic distortion significantly, as MMCs produce a near-sinusoidal output waveform [13]. This inherent quality reduces the need for complex and bulky filtering components, making MMCs suitable for long-distance HVDC applications and high-quality power transmission [14]. MMC-based HVDC systems have been shown to achieve high power quality with reduced total harmonic distortion (THD), contributing to increased efficiency and stability in transmission networks [15]. When compared to previous voltage lift methods like super lift converters and conventional boost converters, ultra-lift converters produce extremely large output transfer gains with geometric growth. When compared, it also provides better efficiency and smaller size [16].

A key benefit of MMCs is their ability to independently control active and reactive power, a crucial factor in modern power systems [17]. This capability enhances grid stability, particularly in systems integrating variable renewable energy sources, including wind and solar [18]. Traditional HVDC systems, typically relying on line commutated converters (LCCs), require robust AC grid support for reactive power, making them unsuitable for weak grids or renewable-heavy applications [19]. In contrast, MMCs incorporate voltage source converter (VSC) technology, which allows flexible operation across weak or fluctuating grid conditions, making them an ideal choice for renewable energy integration and offshore power applications [20]. An inter-pole cooperative control strategy [21] is proposed for an offshore wind-powered MMC-HVDC system that is really bipolar. It has been suggested to use an upgraded fault ride-through method without communication and without a DC chopper [22]. For an HVDC system's two converter stations, two fault ride-through (FRT) techniques are proposed. The master converter station's DC voltage control loop receives one FRT mechanism, while the slave converter station's active power control loop receives the other FRT mechanism [23]. For the MMC, a modified nearest level modulation (NLM) control mechanism is suggested, which yields 2N+1 levels, or twice as many levels as traditional NLM [24]. Three components make up the hierarchical coordinated adaptive strategy and the adaptive droop control that is suggested for MMC inverters [25].

2. MODULAR MULTILEVEL CONVERTERS (MMCs)

MMCs are advanced power converters that play a crucial role in systems that use high voltage direct current (HVDC). MMCs are composed of numerous sub-modules connected in series, which allows for high voltage scalability and modular design flexibility. Key features of MMCs in HVDC applications include:

- High scalability: MMCs can handle high power and voltage levels, making them ideal for HVDC transmission and grid integration of renewable energy sources.
- Reduced harmonic distortion: The converter’s modular structure creates a smoother, nearly sinusoidal voltage waveform, minimizing harmonic distortion and often reducing the need for large external filters.
- Fault tolerance: The modular design allows individual sub-modules to be bypassed in case of faults, enhancing reliability and making maintenance more manageable.
- Efficient energy conversion: MMCs efficiently handle both active and reactive power, allowing for effective voltage control, which is essential in long-distance and high-capacity HVDC transmission.

- Dynamic control: MMCs offer robust dynamic control, including voltage stabilization and reactive power control, which improves grid stability and supports various applications like offshore wind farms and multi-terminal HVDC systems.

MMCs represent a breakthrough in HVDC technology by combining high performance with modular flexibility, supporting sustainable and resilient power transmission. The HVDC transmission system utilizing MMCs offers a powerful and efficient approach for long-distance power transmission, aligning well with the demands of modern electrical networks. In this project, MMCs are utilized to enhance HVDC transmission performance through their modular structure, which consists of multiple sub-modules connected in series. Figure 1 depicts the topology of the three-phase MMC circuit. This configuration enables high voltage and high power scalability, making MMCs particularly suitable for ultra-long-distance HVDC lines and high-capacity applications. The near-sinusoidal output voltage waveform generated by MMCs reduces THD, significantly lowering the need for extensive filtering equipment and contributing to improved power quality. MMCs also support separate management of reactive and active power, which is essential for stabilizing voltage in HVDC systems and integrating variable renewable energy sources such as solar and wind. Figure 2 shows MMC's output voltage.

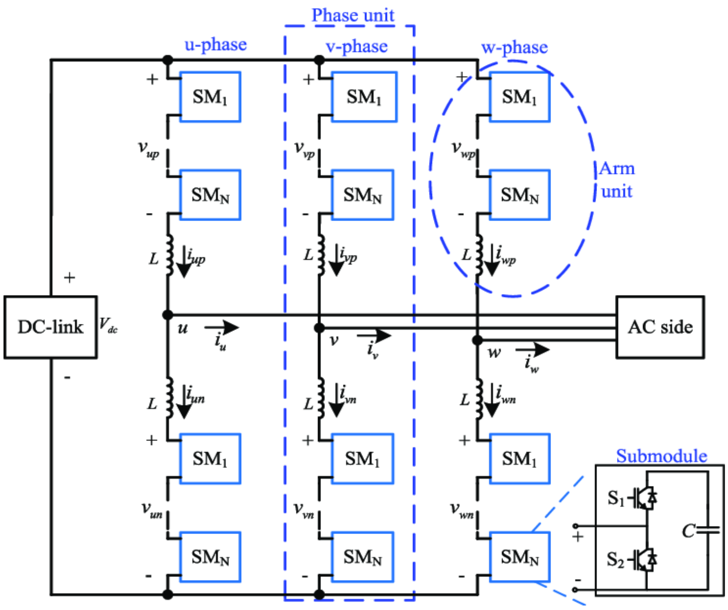

Figure 1. Topology of the three-phase MMC circuit

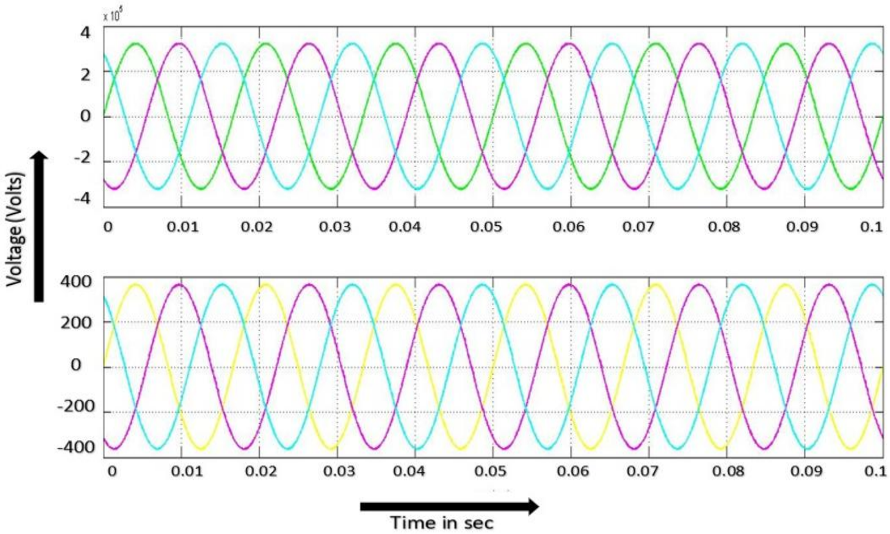

Figure 2. MMC's output voltage

3. PROPOSED MODEL OF AN HVDC TRANSMISSION SYSTEM

According to the suggested model, a 500 MW DC (250 kV, 2 kA) connection is utilized for power transmission from a 5000 MVA, 315 kV AC network. The network is dissembled using a LLR dampened original with an 80-degree impedance angle at 60 Hz, including the 3rd harmonious. The motor motor and the therapy are modeled using the universal bridge and transformer blocks. Instead of the traditional 6-pulse rectifier, an MMC is used for the rectification process. The MMC provides higher efficiency, better harmonic performance, and more flexible operation compared to the conventional 6-pulse rectifier. Figure 3 shows a block diagram of HVDC transmission line.

The MMC 0.5 H smoothing reactor (LsR) connects the system's 300 km distributed parameter transmission line. The inverter type includes a smoothing reactor (LsI) for stabilization and a simple DC voltage source that uses a diode to guarantee one-way flow of current. C-bank capacitors are part of a series of filters used to fulfill the converter's reactive power requirements and filters that focus on higher-order, seventh, and fifth harmonics. When combined, these elements offer a 320 Mvar of reactive power adjustment. Furthermore, a circuit to simulate a rectifier-side DC line fault, a breaker is used. The system of control incorporates two major blocks accompanied 6-palpitation creator (which in this case is acclimated for MMC operation) and a regulator for PI current. The system of control ensures that the voltages transferred are screened before entering the synchronization system through band-pass, second order pollutants. The entire the control system is separated with a gap between slices of 43.4 µsec (1/360/64).

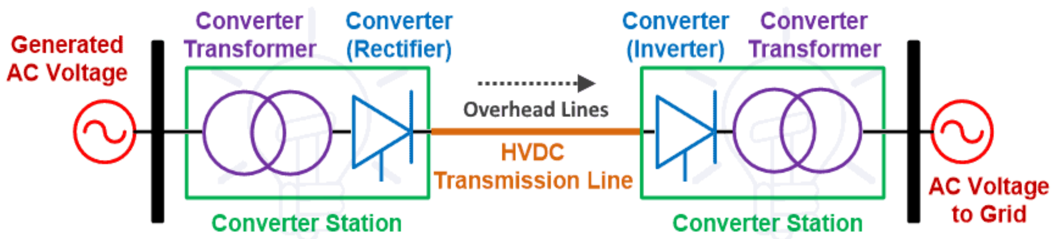

Figure 3. Block diagram of HVDC transmission line

4. SIMULATION RESULTS AND DISCUSSION

The proposed HVDC system, utilizing an MMC for both rectification and inversion, was simulated using MATLAB/Simulink. The system transmits electricity from a 315 kV, 5000 MVA 315 MW DC link that operates at 250 kV and 2 kA. AC network. To evaluate the HVDC system's effectiveness and performance under several operating circumstances, the following simulations were run.

4.1. System configuration

The system configuration used in the simulation includes the following components. A damped LLR equivalent with an 80-degree impedance angle at 60 Hz, including the third harmonic, represents the AC network at 315 kV and 5000 MVA. Converter: a universal bridge and universal transformer block that connects an MMC, or modular multilevel converter an MMC to the AC grid. Compared to conventional 6-pulse converters, the MMC converts AC to DC and vice versa with great efficiency and less harmonic distortion. Transmission line: a distributed parameter line (LsR = 0.5 H) that is 300 km long and has a smoothing reactor. The inverter has a smoothing reactor (LsI) on the inverter side and a basic source of DC voltage connected with a diode in series to compel one-way conduction. A collection of pollutants, including high-pass, fifth, seventh, and C-bank pollutants. Filters: a collection of filters (high-pass, fifth, seventh, and C-bank) providing a 320 Mvar in total reactive power compensation to maintain system stability. Figure 4 depicts the waveform of MMC's voltage.

4.2. Control system design

The control system was implemented using two main blocks. Synchronized MMC generator: This block provides the necessary synchronization for the MMC, ensuring proper control of the voltage and current. PI current regulator: A proportional-integral (PI) regulator was used to compare the DC line current with the reference and adjust the firing angle (alpha) of the converter to maintain minimal error. The entire control system was discretized with a sampling interval of 43.4 µsec (1/360/64). Figure 5 shows the Control voltage waveform.

4.3. Results

Steady-state operation: Under steady-state conditions, the system was able to deliver a continuous 500 MW of power from the 315 kV AC network to the DC side at 250 kV, 2 kA. The MMC converter showed high efficiency, with minimal losses and reduced harmonic distortion, because the THD is low. The values observed on both the DC and AC phases. Transient response: The transient response of the system was tested under fault conditions, such as DC line faults on the rectifier side. When the fault occurred, the circuit breaker was triggered, and the MMC adjusted its operation to prevent damage to the system. After the issue was fixed, the system returned returning to regular operations within a short time, demonstrating the fault-tolerant nature of the HVDC system using MMCs. Recovery time: The system was able to recover from the fault within 100 ms, with the inverter maintaining stability and smoothly ramping up the output voltage and current.

Current regulation: During the fault condition, the PI current regulator effectively adjusted the firing angle to bring the system back to steady-state operation, ensuring the DC line current matched the reference after fault clearance. Figure 6 depicts the resulting waveform of current. Efficiency and harmonics: The efficiency of the system was found to be higher than that of conventional HVDC systems using 6-pulse rectifiers, primarily due to the modular design of the MMC, which reduces harmonic content and improves overall power quality. Power losses: The total system losses were found to be minimal (approximately 1-2% of the transmitted power), which is a significant improvement over traditional HVDC systems. Harmonics: The MMC significantly reduced the harmonic distortion compared to a 6-pulse system. The THD on both the AC and DC sides remained below 2%, indicating high-quality power transmission. Figure 7 depicts the THD value of the output voltage.

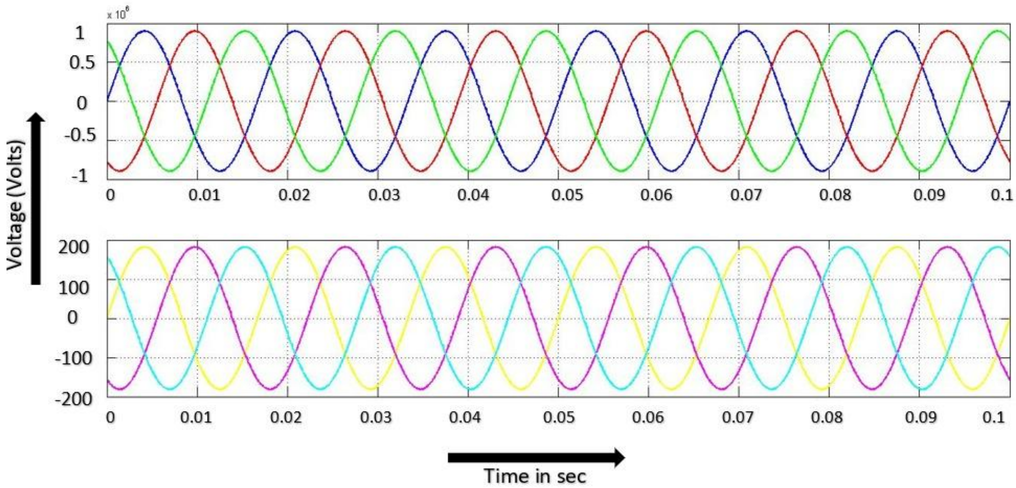

Figure 4. Waveform of MMC's voltage

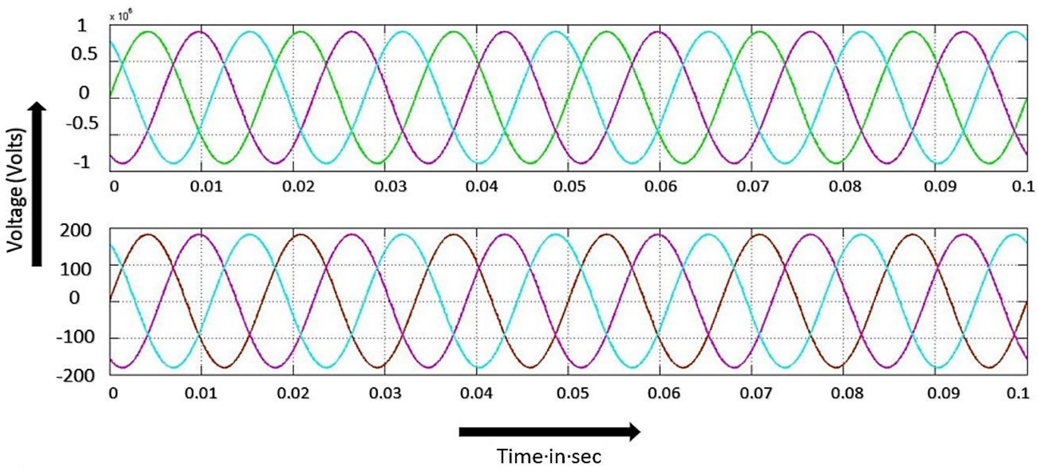

Figure 5. Control voltage waveform

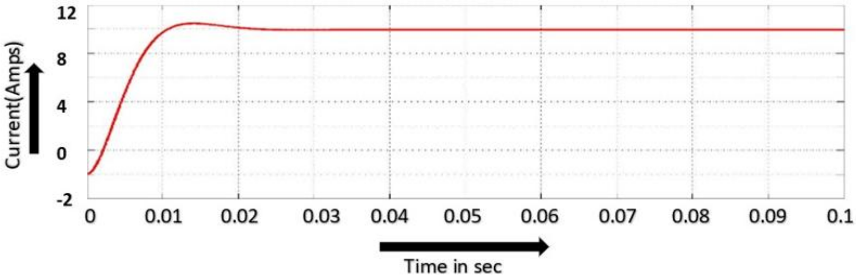

Figure 6. Resulting waveform of current

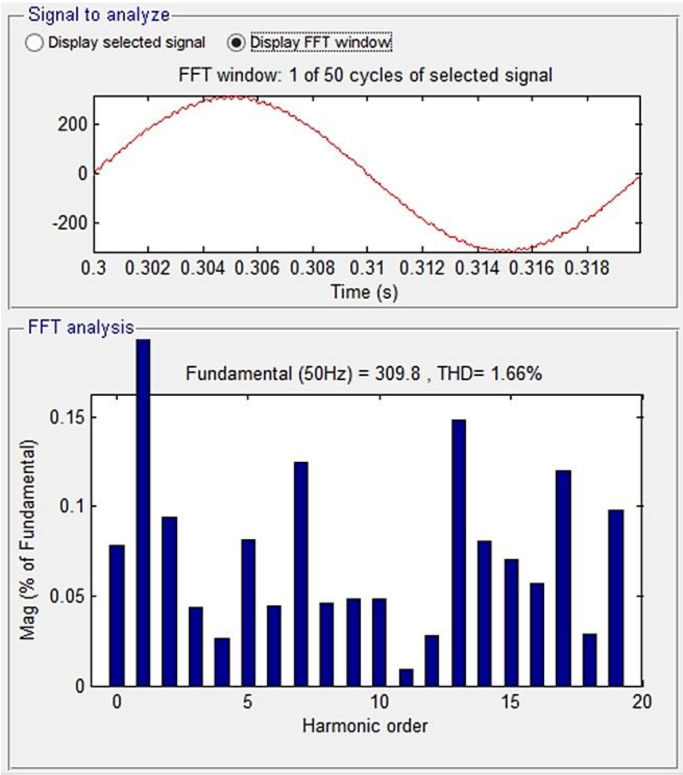

Figure 7. THD vaule of output voltage

5. CONCLUSION

This paper presents the simulation and analysis of a three-phase grid interconnection system using a HVDC link with a three-level MMC, evaluating its performance under various operating conditions. The HVDC link enhances long-distance power transmission by reducing losses, increasing transfer capacity, and ensuring reliable interconnections between grids. The MMC's modular design enables scalability, low harmonic distortion, and reduced switching losses, making it well-suited for high-performance applications. Simulations in MATLAB/Simulink show the system achieving high-quality output waveforms with THD below 2%, along with reduced voltage stress on components, improving overall efficiency. The HVDC link further contributes to stability by damping power oscillations and providing reactive power compensation during load changes and transient events. These results demonstrate that combining HVDC technology with MMCs offers a robust, efficient, and flexible solution for modern grid interconnections. The study highlights the potential of HVDC-MMC systems to transform future power networks by delivering enhanced stability, scalability, and sustainability, while also establishing a strong foundation for further research aimed at optimizing their efficiency, reliability, and integration into next-generation energy infrastructures.

FUNDING INFORMATION

This research was funded by Teegala Krishna Reddy Engineering College.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Madhububu Thiruveedula	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	
Nenavath Ramesh Babu		✓	✓			✓		✓	✓	✓	✓	✓		
Penagonda Akash	✓	✓	✓	✓			✓			✓	✓		✓	✓
Guthula Sravya Bhavana	✓	✓		✓	✓		✓		✓		✓		✓	
Devasoth Arjun	✓		✓		✓		✓			✓		✓		✓
Gavvala Chethan	✓		✓			✓		✓	✓					✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [MT], upon reasonable request.

REFERENCES

[1] A. M. Vural and E. N. Wirsiy, "Three-phase modular multilevel converter based unified power flow controller," *Engineering Science and Technology, an International Journal*, vol. 23, no. 2, pp. 299–306, Apr. 2020, doi: 10.1016/j.jestch.2019.05.009.

[2] M. Ahmad, C. Gong, M. H. Nadeem, H. Chen, and Z. Wang, "A hybrid circuit breaker with fault current limiter circuit in a VSC-HVDC application," *Protection and Control of Modern Power Systems*, vol. 7, no. 4, pp. 1–13, Dec. 2022, doi: 10.1186/s41601-022-00264-9.

[3] N. B. Kadandani, S. Hassan, and I. Abubakar, "On the suitability of modular multilevel converter (MMC) in high voltage direct current (HVDC) transmission system," *Fudma Journal of Sciences*, vol. 7, no. 3, pp. 318–323, Sep. 2023, doi: 10.33003/fjs-2023-0703-1963.

[4] K. Yamashita, G. Tsukamoto, and S. Nishikata, "Steady-state characteristics of a line-commutated converter-based high-voltage direct current transmission system for series-connected wind power plants," *IEEE Transactions on Industry Applications*, vol. 56, no. 4, pp. 3932–3939, Jul. 2020, doi: 10.1109/TIA.2020.2986984.

[5] M. S. Bhutta, T. Xuebang, M. Faheem, F. M. Almasoudi, K. S. S. Alatawi, and H. Guo, "Neuro-fuzzy based high-voltage DC model to optimize frequency stability of an offshore wind farm," *Processes*, vol. 11, no. 7, p. 2049, Jul. 2023, doi: 10.3390/pr11072049.

[6] I. I. Hussein, S. Essallah, and A. Khedher, "The impact of HVDC on the current and future energy markets," *International Journal of Electrical and Electronic Engineering and Telecommunications*, vol. 11, no. 6, pp. 426–434, 2022, doi: 10.18178/ijeetc.11.6.426-434.

[7] L. Jia, S. Hu, Y. Liu, Q. Liu, H. Cai, and J. Deng, "Research on corrosion behavior of X80 steel under HVDC interference," in *2023 2nd International Conference on Power Systems and Electrical Technology (PSET)*, Aug. 2023, pp. 1–6, doi: 10.1109/PSET59452.2023.10346280.

[8] L. Liu and E. Yu, "Heat dissipation performance analysis of IGBT module for flexible HVDC converter valve based on field-circuit combined simulation," in *2022 IEEE 5th International Conference on Electronics Technology (ICET)*, Chengdu, China, 2022, pp. 516–520, doi: 10.1109/ICET55676.2022.9824222.

[9] S. J. Kim, D. G. Lee, J. H. Kim, and B. W. Lee, "Numerical analysis of electric field characteristics and interfacial pressure of HVDC XLPE cable joint considering load cycles," *Energies*, vol. 15, no. 13, 2022, doi: 10.3390/en15134684.

[10] T. T. N. Vu, G. Teyssedre, and S. Le Roy, "Electric field distribution in hvdc cable joint in non-stationary conditions," *Energies*, vol. 14, no. 17, 2021, doi: 10.3390/en14175401.

[11] Z. Wu, J. Chu, W. Gu, Q. Huang, L. Chen, and X. Yuan, "Hybrid modulated model predictive control in a modular multilevel converter for multi-terminal direct current systems," *Energies*, vol. 11, no. 7, p. 1861, 2018, doi: 10.3390/en11071861.

[12] R. Alaei and S. A. Khajehoddin, "Series hybrid modular multilevel converter for HVDC transmission systems," *IEEE Access*, vol. 12, pp. 76816–76825, 2024, doi: 10.1109/ACCESS.2024.3406739.

[13] R. H. Chandio *et al.*, "Control and protection of MMC-based HVDC systems: a review," *Energy Reports*, vol. 9, pp. 1571–1588, Dec. 2023, doi: 10.1016/j.egyr.2022.12.056.

[14] J. B. Soomro, F. Akhtar, R. Hussain, J. A. Ansari, and H. M. Munir, "A detailed review of MMC circuit topologies and modelling issues," *International Transactions on Electrical Energy Systems*, vol. 2022, no. 1, pp. 1–17, Mar. 2022, doi: 10.1155/2022/8734010.

[15] T. Madhubabu, A. Anireddy, N. Sahithi, K. S. Krishna Suman, S. Vikas, and K. Chenchireddy, “Reduction of harmonics to improve power quality in distribution lines using a series active power filter,” in *2023 7th International Conference on Trends in Electronics and Informatics (ICOEI)*, Tirunelveli, India, 2023, pp. 123–128, doi: 10.1109/ICOEI56765.2023.10126006.

[16] T. M. Babu, K. Chenchireddy, J. Rohini, and M. S. Suhas, “High voltage DC-DC converter with standalone application,” *International Journal of Applied Power Engineering*, vol. 12, no. 4, pp. 384–390, 2023, doi: 10.11591/ijape.v12.i4.pp384-390.

[17] Y. Tian, H. R. Wickramasinghe, Z. Li, J. Pou, and G. Konstantinou, “Review, classification and loss comparison of modular multilevel converter submodules for HVDC applications,” *Energies*, vol. 15, no. 6, p. 1985, Mar. 2022, doi: 10.3390/en15061985.

[18] D. Anusha, D. De, A. C. Tiwari, and S. Sahu, “Modelling and control of synthetic inertia controller for modular multilevel converter fed HVDC systems,” in *2023 5th International Conference on Energy, Power and Environment: Towards Flexible Green Energy Technologies (ICEPE)*, Jun. 2023, pp. 1–6, doi: 10.1109/ICEPE57949.2023.10201648.

[19] T. M. Babu, K. Chenchireddy, K. Sreevarsha, B. Praveen, M. Thanveer, and G. Kashinadh, “CHBMLI based DSTATCOM for power quality improvemt in a three-phase three-wire distribution system with PI controller,” *International Journal of Advances in Applied Sciences*, vol. 13, no. 2, pp. 325–332, 2024, doi: 10.11591/ijaas.v13.i2.pp325-332.

[20] B. Zhao *et al.*, “Practical analytical model and comprehensive comparison of power loss performance for various MMCs based on IGCT in HVDC application,” *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 7, no. 2, pp. 1071–1083, Jun. 2019, doi: 10.1109/JESTPE.2018.2871191.

[21] Y. Chen, S. Zhong, Y. Zhang, C. Li, F. Zhou, and Y. Che, “Inter-pole cooperative control strategy for true bipolar MMC-HVDC system with offshore wind power,” *Journal of Physics: Conference Series*, vol. 2662, no. 1, 2023, doi: 10.1088/1742-6596/2662/1/012031.

[22] J. Badar *et al.*, “An MMC based HVDC system with optimized AC fault ride-through capability and enhanced circulating current suppression control,” *Frontiers in Energy Research*, vol. 11, 2023, doi: 10.3389/fenrg.2023.1190975.

[23] S. D. Tavakoli, E. Prieto-Araujo, and O. Gomis-Bellmunt, “AC fault ride through in MMC-based HVDC systems,” *IEEE Transactions on Power Delivery*, vol. 37, no. 4, pp. 2775–2786, 2022, doi: 10.1109/TPWRD.2021.3116508.

[24] S. Ali, J. B. Soomro, M. Mughal, F. A. Chachar, S. S. H. Bukhari, and J. S. Ro, “Power quality improvement in HVDC MMC with modified nearest level control in real-time HIL based setup,” *IEEE Access*, vol. 8, pp. 221712–221719, 2020, doi: 10.1109/ACCESS.2020.3043811.

[25] J. Zhao and Y. Tao, “Hierarchical coordinated adaptive droop control for hybrid HVDC with cascaded multi-infeed MMC inverters,” *IET Renewable Power Generation*, vol. 16, no. 6, pp. 1148–1158, 2022, doi: 10.1049/rpg2.12397.

BIOGRAPHIES OF AUTHORS

Madhubabu Thiruveedula received B.Tech. from JNTU Hyderabad, Telangana, India, in 2010, and M.Tech. from NIT Calicut 2013, respectively, and pursuing Ph.D. in Annamalai University, Tamil Nadu, India. He is presently working as an assistant professor in Department of Electrical and Electronics Engineering at Teegala Krishna Reddy Engineering College, Hyderabad, India. He has presented technical papers in various national and international journals and conferences. His areas of interest include power systems, power electronics, and power quality. He can be contacted at email: madhumk448@gmail.com.

Nenavath Ramesh Babu is presently working as an assistant professor in Department of Electrical and Electronics Engineering at Teegala Krishna Reddy Engineering College, Hyderabad, India. His areas of interest include control systems, power systems, and power electronics. He can be contacted at email: rameshbabu3889@tkrec.ac.in.

Penagonda Akash received the diploma from Jyothismathi Institute of Technology Science (JMTS), Karimnagar, in 2022. He is presently a UG student in electrical and electronics engineering at Teegala Krishna Reddy Engineering College, Hyderabad, India. He completed internship in diploma in 132 kV / 33 kV Substation RTS-B, Ramagundam, Peddapalli district. He has an interest in power systems and machines. He can be contacted at email: penagondaakash789@gmail.com.

Guthula Sravya Bhavana received the diploma from Srinivasa Institute of Engineering and Technology, Cheyyeru, Mummidivaram [Mandal], Dr. B.R. Ambedkar Konasema [district] in 2022. She is presently a UG student in electrical and electronics engineering at Teegala Krishna Reddy Engineering College, Hyderabad, India. She completed internship in diploma in 33 kV / 11 kV Substation APEPDCL, Dr. B.R. Ambedkar district. She has an interest in power systems and machines. She can be contacted at email: bhavanasravya1@gmail.com.

Devasoth Arjun received the diploma from Vijay Rural Engineering College, Dasnagar, Nizamabad in 2022. He is presently a UG student in electrical and electronics engineering at Teegala Krishna Reddy Engineering College, Hyderabad, India. He completed internship in diploma in 132 kV / 33 kV Substation, Dasnagar, Nizamabad. He has an interest in power systems and machines. He can be contacted at email: devasotharjun8@gmail.com.

Gavvala Chethan received the diploma from SSRS GPT, Sricilla district in 2021. He is presently a UG student in electrical and electronics engineering at Teegala Krishna Reddy Engineering College, Hyderabad, India. He completed internship in diploma in 132 kV / 33 kV Substation RTS-B, Ramagundam, Peddapalli district. He has an interest in power systems and machines. He can be contacted at email: chethan8652@gmail.com.