Enhance Grid Current Of Three-Terminal Hybrid Micro-Grid With CHB VSC Converters

M. Surendar, T. Venkatesh, A. Suresh

Abstract: In this article, proposed a three-terminal Cascade H Bridge (CHB) based hybrid micro-grid with one AC terminals and one AC terminal. This approach operates cascaded H-bridge (CHB) converters based AC grid interface and two dual active bridge (DAB) converters based DC sub-grid interface that connects two isolated DC buses. This inter connection suppress the no. of power conversation stages. DAB converters fed CHB converters operates based on DC rails. To overcome the unbalanced grid voltage & currents and DC rail voltages issues caused by this modified system configuration with only two power conversion stages, an improved method is proposed through the zero-sequence voltage injection in the CHB converters.

Index Terms: cascaded H-bridge (CHB) converters, DAB converters, Zero-sequence voltage injection

1. INTRODUCTION

Due to rapid increment in production of DC power generations like solar and fuel cell the applications of DC grids are growing. Almost all power semi conductor devices speed adjustable motor drives, excitation to the alternating machines, electrical vehicles and communication Systems the need of DC supply is high. To fulfil the AC/DC loads the AC to DC converters are playing crucial role. In this paper CHB bi directional voltage sources are employed to integrate the hybrid power generations and utilize it. Flying capacitor (FC) and Neutral point clamped (NPC) are available in the literature instead of CHB multi level converters, CHB are more advantageous compared to FC and NPC like reduced switches, mode of operations and it is best suitable of medium and high power transmission systems. The conventional hybrid AC/DC grids include single AC bus and DC bus. These converters output terminals are integrated by three-phase bidirectional AC/DC converter. The output of AC terminal is connected to grid (low voltage side). High frequency linear transformer is used to interconnect source and load. Linear transformer have few disadvantages like larger in weight, heavy volume and need more insulation oil. So instead of transformers AC/DC converters are employable. Power semiconductor elements have more efficient compare to linear transformer. To achieve power demand multi terminal hybrid AC/DC micro grids are growing very popular. In advance multi terminal micro grid systems are using much. This have higher power transmission capability rate with more economical ratios. To get desired output multi terminal power transmission CHB topology is adoptable with dual active bridge (DAB) converters. The block diagram of traditional AC/DC micro grid system is shown in below figure.1

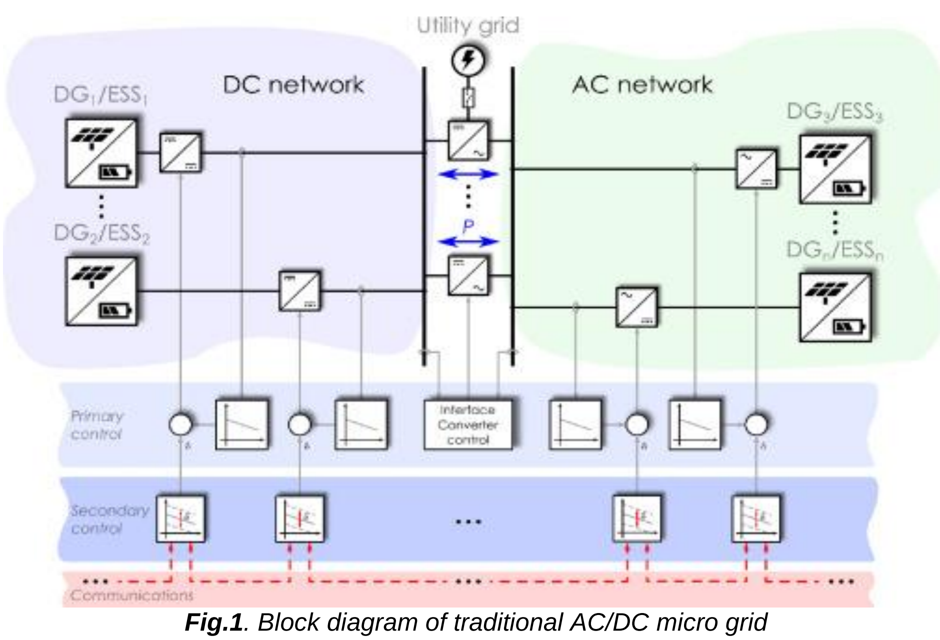

***Fig.1**. Block diagram of traditional AC/DC micro grid*

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2. SYSTEM CONFIGURATION:

In Conventional Power quality is easily improved by using Active Power Filters (APFs) and the Distribution Static Compensators (DSTATCOMs). The DSTATCOM is a shunt voltage controller device. In this Voltage Source Inverter (VSI) connected in shunt at the point of common coupling (PCC) of three phase distribution systems. So many authors proposed various methods on DSTATCOM configuration. To reduce the harmonics in currents, inject reactive power, suppress the neutral wire current and improve power factor. Most of these configurations are designed based on VSI connection at the PCC.

In this paper adopted CHB inverter rather than three leg inverters. The advantages four - leg VSI are; it reduces the source neutral wire current completely and circum vent the problems associated with the others VSI topologies.

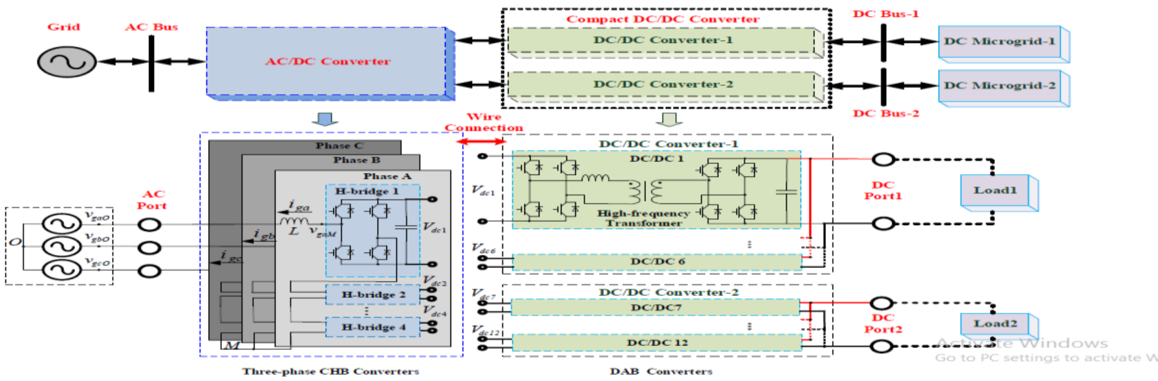

***Fig.2**. Configuration of three-terminal proposed hybrid micro-grid*

3. CONTROL SCHEME:

To operate voltage source inverters (switch pattern) design controllers like sliding mode controller, cascade controllers, μ- synthesis method, model predictive power control (MPTC), adaptive control and direct power control (DPC). To design these control strategies need a lot of knowledge about process (micro-grid). It much depends on the proportional gain (K_P) value. Still prime research is work is going on this era because of PID controllers more advantages. It is a self tuned controller with expert algorithm approaches, so as a result a few controllers are giving an attractive acceptable result and some controllers are giving not desirable response. the practical switching action of VSC is implemented by employing various control strategies like SRF theory, P-Q theory, PV theory, compensation theory, hysteresis controllers and PI controllers. In this project to control VSC operation direct SRF control approach is adopted with includes hysteresis controllers. The control block diagram is presented in figure.3 and described. The implementation SRF frame theory is very simple and easily implemented it involves Parks and Clarkes matrix transformations, such abc to dqo and dqo to abc transformations. These conversations are more helpful to synthesis means it is used to estimate fault waveform amplitude severity and its frequency. The abc to dqo is a conversation in simplex manner defined as of A.C signal into D.C signal. Because of switching operation few inrush currents/voltages may be circulates in the networks this can be reduced higher amount by employing LC filters.

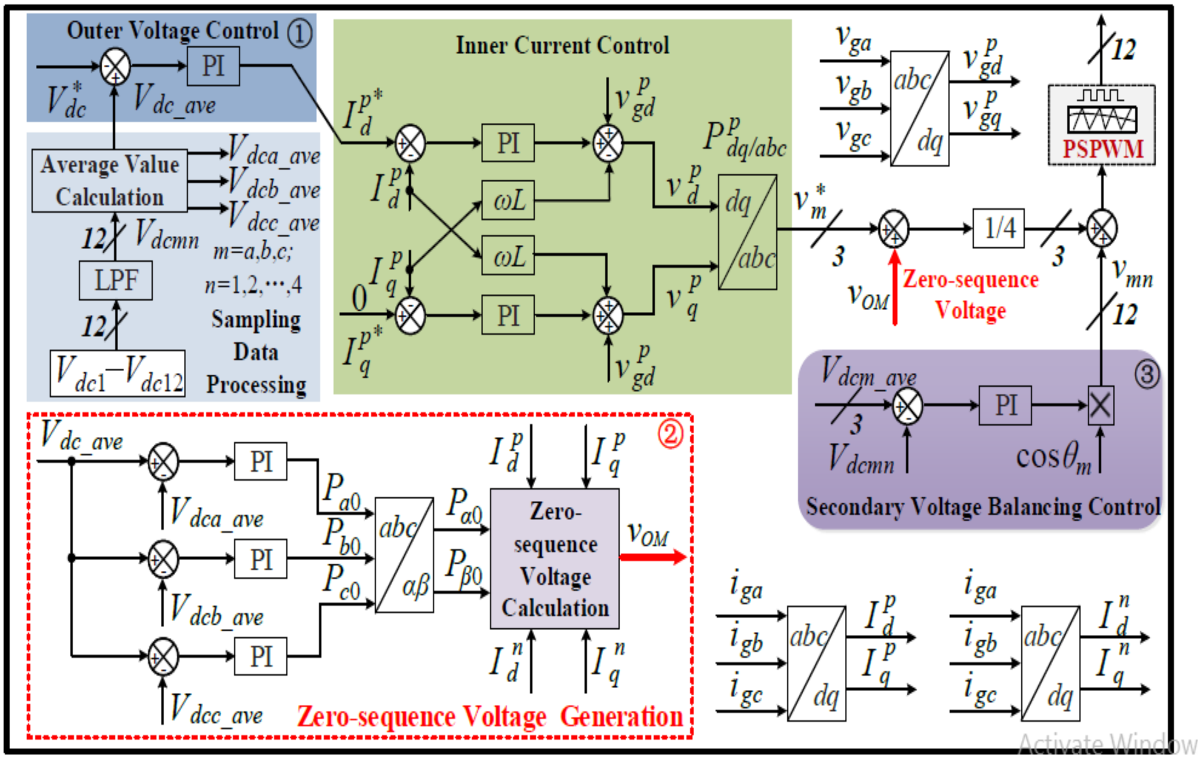

Fig.3a. *Control scheme of hybrid micro-grid*

4. MATLAB & Simulation Results:

The MATLAB simlink of Grid connected Three-Terminal Hybrid Micro-grid with CHB VSC converters is shown in figure.3b

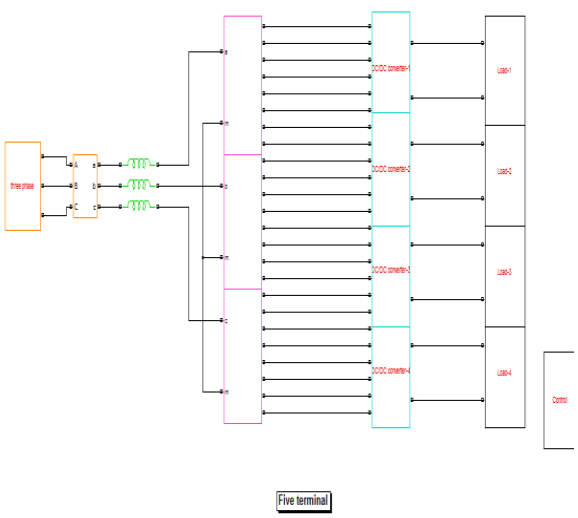

Fig.3b. *Structure of Hybrid micro grid with CHB converters*

The control scheme of micro-grid with CHB converters are is shown in figure.3c

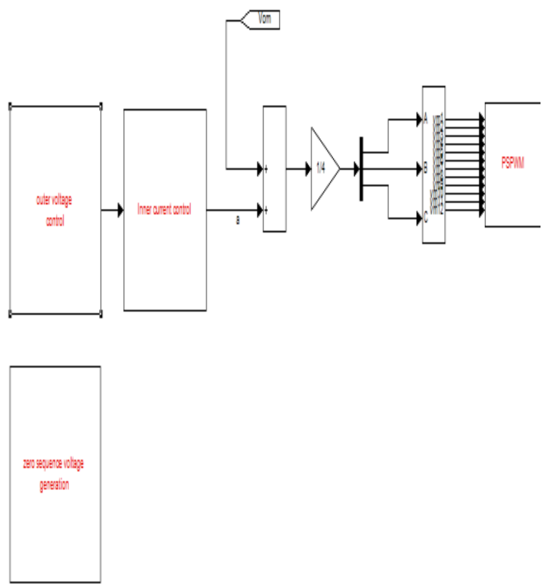

Fig.3c*. Control scheme*

The interconnection of H Bridge converters in cascade manner is shown in figure.3d. The Simulation results are in traditional approach is shown below figures 4, 5 and 6 respectively.

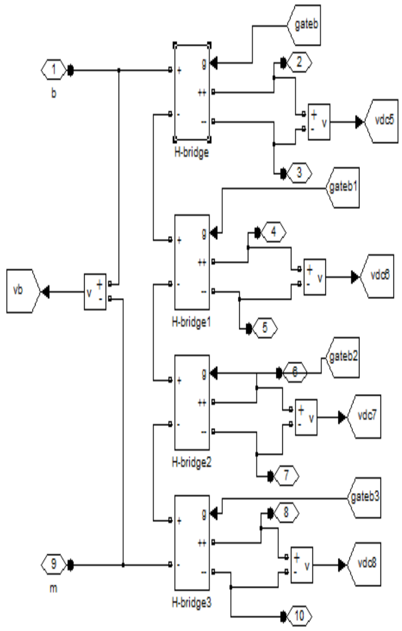

Fig.3d. *Structure of Cascade H Bridge converters*

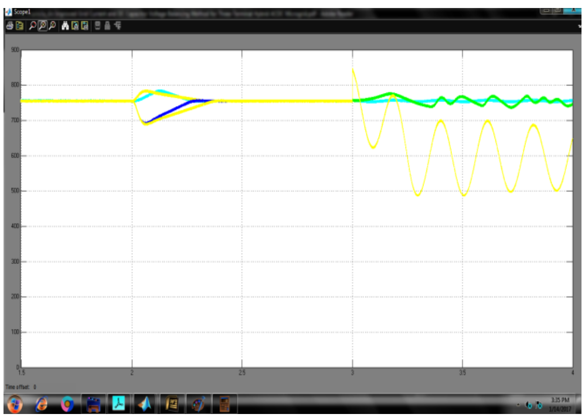

Fig.4*. DC capacitor voltages of AC/DC converter in conventional method*

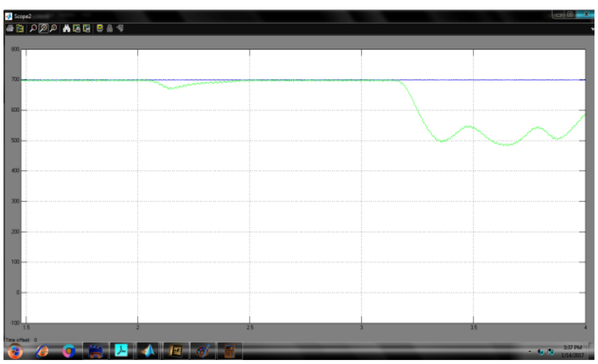

Fig.5*. AC/DC converter output voltage and output current*

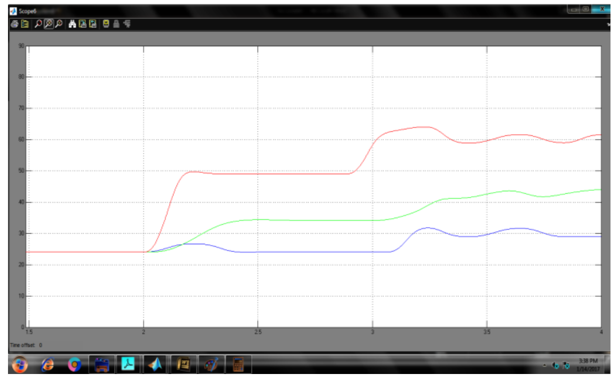

Fig.*6 Rms current*

The improved matlab simulation results in Proposed method at three terminal is shown below figures 7,8, 9, 10 and 11 respectively.

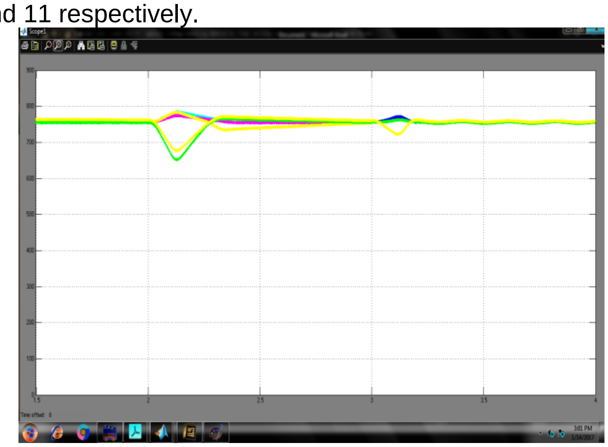

Fig.7*. DC capacitor voltages of AC/DC converter by the proposed method.*

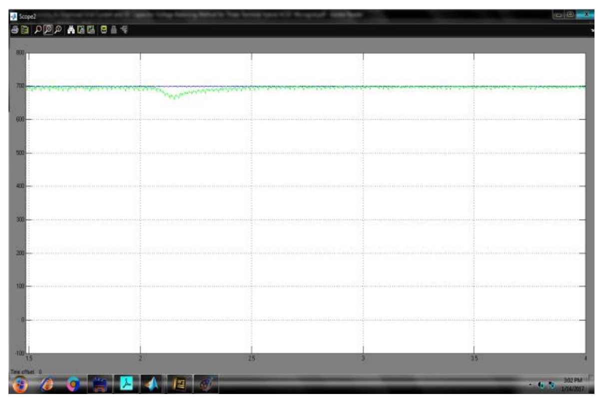

Fig.8*. AC/DC converter output voltage and output current*

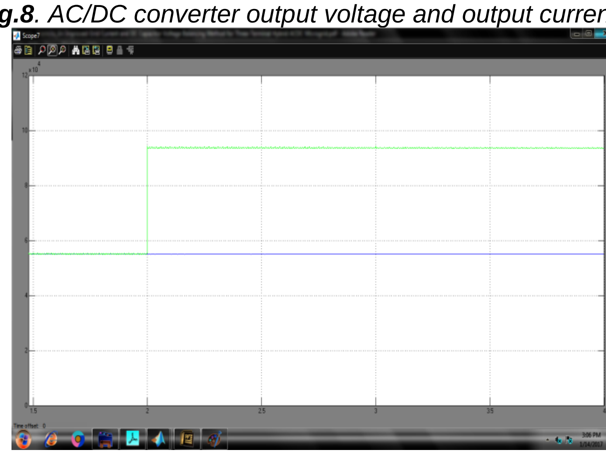

Fig.9. *Dc microgrid power 1 & 2*

Fig.10. *Rms current*

Fig.11 *output Dc/dc voltages*

The improved matlab simulation results in Proposed method at five terminal is shown below figures 12, 13,14,15, 16 and 17 respectively.

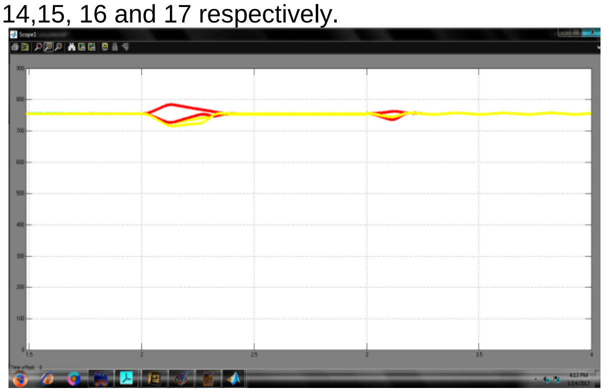

Fig.12 DC *capacitor voltages of AC/DC converter by the proposed method*

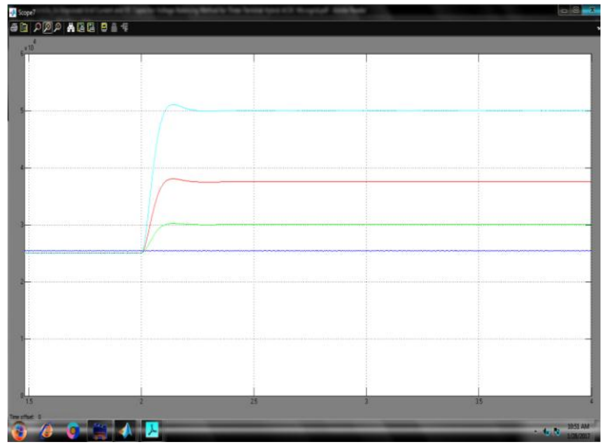

Fig.13.*Micro grid powers*

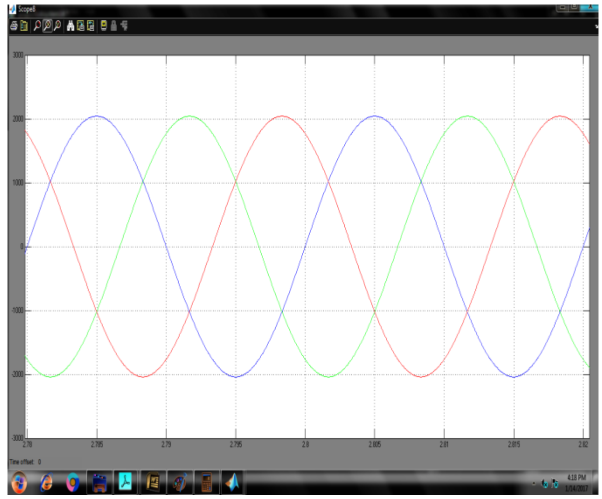

Fig.14 Grid*-1 Output voltages*

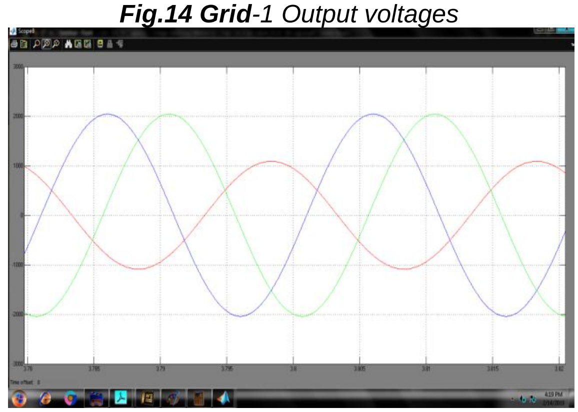

Fig.15 Grid*-2 output voltages*

Fig.16 *Rms current*

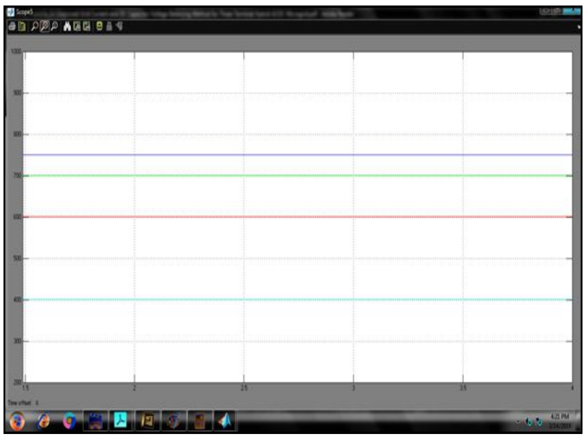

Fig.17. *Output Dc/dc voltage*

5. CONCLUSION:

A two port hybrid micro-grid with two power conversations and A three port hybrid micro-grid with two DC terminals structure has been investigated in this article in detail with MATLAB simulation results. From the obtained output simlink results it clearly evident that a hybrid micro grid with three terminals VSC converters solve unbalance DC capacitor voltages. Generally capacitive voltage is unbalances in micro/smart grids due to AC/DC or DC/AC VSC converters presence. This problem is greatly overcome by adopting CHB Bridge VSC converters. This CHB Bridge operates with zero-sequence voltage approach. This proposed method improves the grid current to more sinusoidal (harmonic free) and enhance overall performance of the performance of hybrid micro-grid.

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