International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 02 | Feb 2019 www.irjet.net p-ISSN: 2395-0072

DESIGN AND SIMULATION OF MULTILEVEL STATCOM USING CASCADE TOPOLOGY

Shrikant M. Joshi[1], Ganesh Wakte[2]

[1]Researcher, Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur, India
[2]Asst. Professor, Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur, India

---

Abstract - *Whenever we consider any algorithm for designing the STATCOM, it is necessary for that the multilevel converter is balancing the induced capacitor which is connected in the star configuration. The issue related to capacitor voltage balancing at the zero average current mode is a main problem which needs to be overcome. Our method proposes a modulation technique for balancing the H-bridge cascaded multilevel converter operated at a zero average current mode. The proposed algorithm modifies the conventional algorithm and we have used STATCOM to enhance its effect. Several practical limitations such as voltage drop, noise, grid voltage, and harmonics are also considered in this model.*

***Key Words*: Cascaded H-bridge, STATCOM, capacitor voltage, and harmonics.**

1. INTRODUCTION

Multilevel converters, nowadays, are mostly use an implemented power converters for high power and voltage applications. The output voltage waveforms of a multilevel converter are synthesized by selecting different voltage levels obtained from DC voltage source of each model. To overcome this challenge STATCOMs are used. In this paper, we are going to use STATCOM for the reactive power. In high power requirement, reactive power compensation is done by multilevel inverters. Cascaded multilevel inverter topology has become very popular choice for the implementation of high power STATCOM systems.

To maintain a continuous and balanced DC line link voltage in each H-bridge and to supply reactive power, 9 level bridges are used. The topology used in for the cascaded multilevel inverter is Sinusoidal Phase Shift Carrier (SPSC) PWM. The simulation results of multilevel STATCOM for different load change are evaluated using different control strategies.

2. MODULATION SCHEME:

The cascaded H-bridge multilevel topology is used as one of the more suitable topology for reactive power compensation application. Here, we have H-bridge multilevel converter based STATCOM control strategy which is used to provide the DC link voltage of the inverter and to keep it balanced in all circumstances. The reactive power produced by the STATCOM is equally well distributed among all H-bridges.

3. PROPOSED CASCADED MULTILEVEL STATCOM DESIGN:

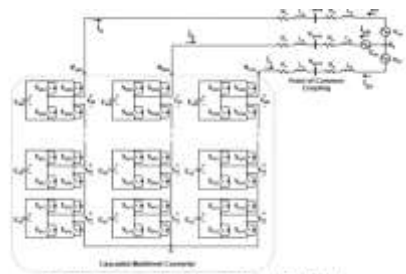


Fig. 1 Configuration of the Cascaded H-bridge STATCOM

Fig (1) shows the circuit configuration star configured STATCOM H-bridge PWM converter in each phase and it can be expanded easily according to the requirement. By controlling the current of the STATCOM directly, it can provide the required reactive current to achieve current compensation.

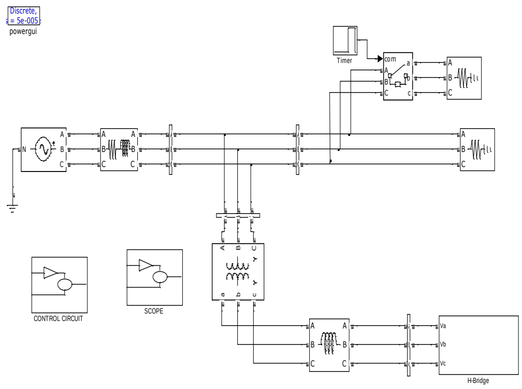
TABLE - I		
CIRCUIT PARAMETERS OF THE EXPERIMENTAL SYSTEM		
Grid Voltage	Us	10 KV
Rated Reactive Power	Q	2 MVA
AC Inductor	L	10 mH
Starting Resistor	Rs	4 KΩ
DC- link Capacitors	Cdc	5600 µF
DC- link reference Voltage	Vdc	600 V
Number of H bridges	N	9
Carrier Frequency	fc	2.4 KHz

Here 3 phase STATCOM is attached to the load and the fundamentals of the STATCOM with extensive parameters of the H-bridge are given in the table.

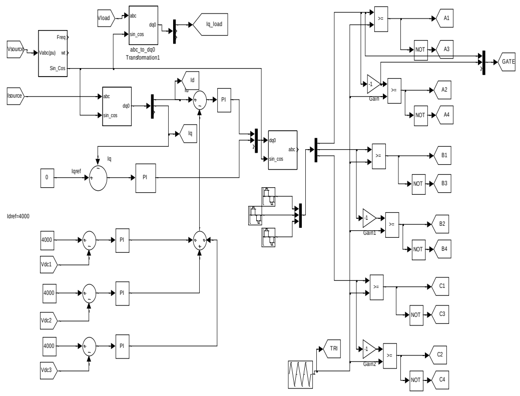
4. DETAIL DESCRIPTION:

Multilevel power converter structures have been introduced in a high power and medium voltage situation. Renewable energy source such as photovoltaic, wind and fuel cells can be easily interfaced to a multilevel converter system for high power application. The term multilevel begins with 3 level converter and is referred to the power electronics circuit that could operate either in an inverter or a rectifier mode. It is basically use to achieve high power with various lower voltage dc sources which are capacitor, battery and renewable energy voltage source which can be used as a multiple dc voltage sources. Static synchronous compensator i.e. STATCOM is utilised at a PCC to absorb or inject the reactive power. H-bridge cascaded STATCOM has a quick response speed, higher efficiency, low distortion, minimum interaction with the supply grid and phase control ability.

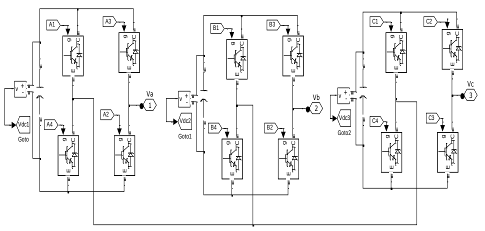
5. SIMULATION OF CASCADED H-BRIDGE:



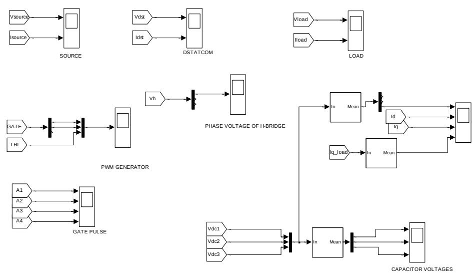
D-STATCOM Openloop



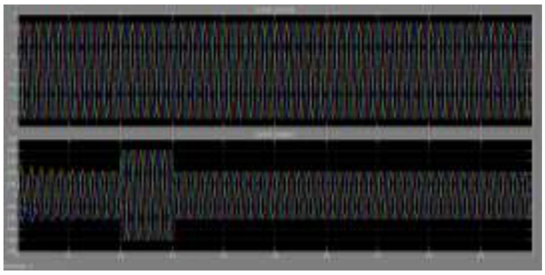
CONTROL CIRCUIT



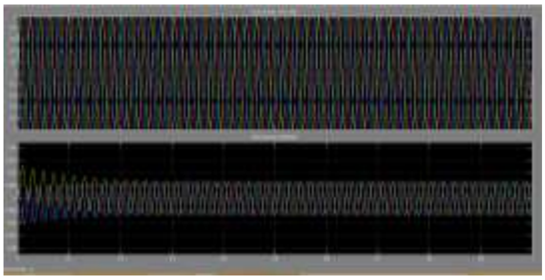
H-BRIDGE



SCOPE

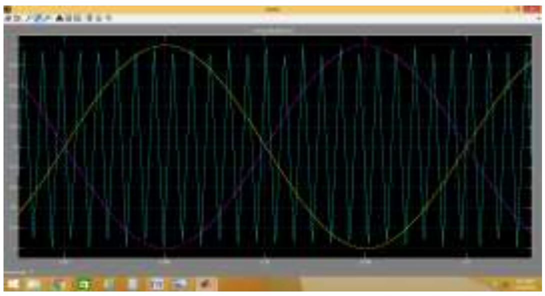


SOURCE VOLTAGE AND SOURCE CURRENT

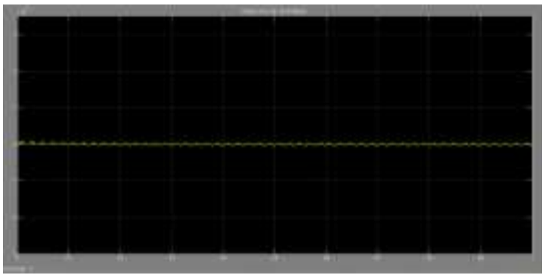


DSTATCOM VOLTAGE AND CURRENT

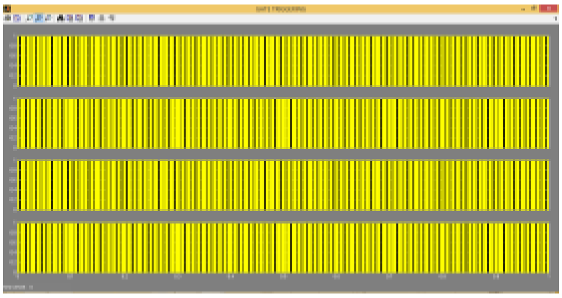
LOAD VOLTAGE AND LOAD CURRENT



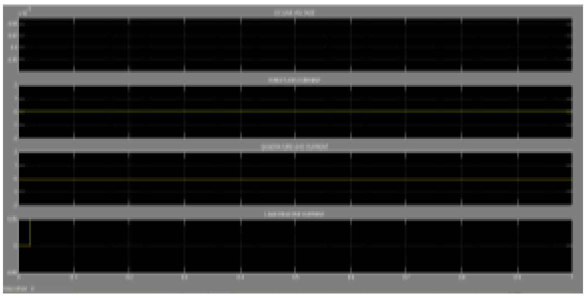
PWM GENERATOR WAVEFORMS



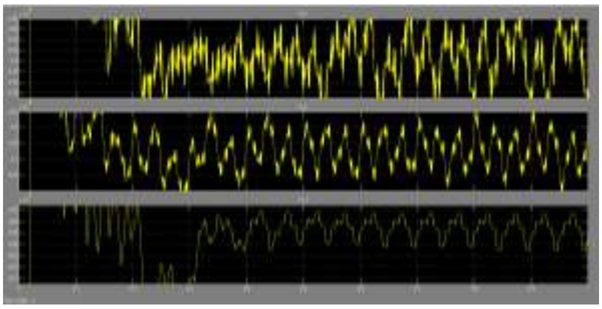
PHASE VOLTAGE OF H-BRIDGE



GATE PULSE



DC LINK VOLTAGE, DIRECT AXIS CURRENT, QUADRATURE AXIS CURRENT AND LOAD REACTIVE CURRENT



CAPACITOR VOLTAGES

6. CONCLUSION:

In this paper we have studied different viabilities of the low capacitance cascaded H-bridge system for better performance. The proposed system is experimentally verified with the help of the prototype with extremely low capacitance values. The main concept in this paper is that it allows large capacitor voltage variation with low H-bridge capacitance value. This paper utilizes the concept to significantly reduce the computational power required to implement the filtering of the capacitor voltage. Here we have proposed 9 level H-bridge inverter. With the help of STATCOM we can easily achieve the higher performance, high efficiency, low distortion and low dc line link voltage.

7. REFERENCES:

[1] B. Gultekin and M. Ermis, “Cascaded multilevel converter-based transmission STATCOM: System design methodology and development of a 12 kV ±12 MVAr power stage,” IEEE Trans. Power Electron., vol/issue: 28(11), pp. 4930–4950, 2013.

[2] B. Gultekin, et al., “Design and implementation of a 154-kV±50-Mvar transmission STATCOM based on 21-level cascaded multilevel converter,” IEEETrans. Ind. Appl., vol/issue: 48(3), pp. 1030–1045, 2012.

[3] S. Kouro, et al., “Recent advances and industrial applications of multilevel converters,” IEEE Trans. Ind. Electron., vol/issue: 57(8), pp. 2553–2580, 2010.

[4] F. Z. Peng, et al., “A multilevel voltage-source inverter with separate DCsources for static var generation,” IEEE Trans. Ind. Appl., vol/issue: 32(5), pp. 1130–1138, 1996.

[5] Y. S. Lai and F. S. Shyu, “Topology for hybrid multilevel inverter,” Proc. Inst. Elect. Eng.—Elect. Power Appl., vol/issue: 149(6), pp. 449–458, 2002.

[6] D. Soto and T. C. Green, “A comparison of high-power converter topologies for the implementation of FACTS controllers,” IEEE Trans. Ind.Electron., vol/issue: 49(5), pp. 1072 1080, 2002.

[7] C. K. Lee, et al., “Circuit-level comparison of STATCOM technologies,” IEEE Trans. Power Electron., vol/issue: 18(4), pp. 1084–1092, 2003.

[8] H. Akagi, et al., “Control and performance of a transformerless cascade PWM STATCOM with star configuration,” IEEETrans. Ind. Appl., vol/issue: 43(4), pp. 1041–1049, 2007.

[9] A. H. Norouzi and A. M. Sharaf, “Two control scheme to enhance the dynamic performance of the STATCOM and SSSC,” IEEE Trans. PowerDel., vol/issue: 20(1), pp. 435–442, 2005.

[10] C. Schauder, et al., “Operation of ±100 MVAr TVA STATCOM,” IEEE Trans.Power Del., vol/issue: 12(4), pp. 1805–1822, 1997.

[11] C. H. Liu and Y. Y. Hsu, “Design of a self-tuning PI controller for a STATCOM using particle swarm optimization,” IEEE Trans. Ind. Electron., vol/issue: 57(2), pp. 702–715, 2010.

[12] S. Mohagheghi, et al., "A proportional-integrator type adaptive critic design-based neurocontroller for a static compensator in a multimachine power system," IEEETrans. Ind. Electron., vol/issue: 54(1), pp. 86–96, 2007.

[13] H. F. Wang, et al., "Application of cell immune response modelling to power system voltage control by STATCOM," Proc. Inst.Elect. Eng. Gener. Transm. Distrib., vol/issue: 149(1), pp. 102–107, 2002.

[14] A. Jain, et al., "Voltage regulation with STATCOMs: Modeling, control and results," IEEE Trans. Power Del., vol/issue: 21(2), pp. 726–735, 2006.

[15] V. Spitsa, et al., "Design of a robust state feedback controller for a STATCOM using a zero set concept," IEEETrans. Power Del., vol/issue: 25(1), pp. 456–467, 2010.