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Investigation on Fourteen Bus System Using Seven Level D-STATCOM

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Abstract

This work deals with modeling and simulation of fourteen bus system using MLI (Multi Level Inverter) based D-STATCOM. The DSTATCOM is a good choice to improve the voltage stability of multi bus system. Simulation studies are performed on fourteen bus system with three level and seven level based MLIs. The simulation results are compared by using THD. The FFT analysis indicate that THD of seven level DSTATCOM is less than that of three level D-STATCOM.

Keywords: MLI, FFT, SMES, Real power flow, Voltage Stability, Available Transfer Capability.

I. INTRODUCTION

Understanding FACTS. Concepts and Technology of Flexible AC Transmission Systems is given by Hingorani VSC based D-STATCOM controller for damping multi-mode oscillations is presented by Zhang Damping inter-area oscillations in power systems by D-STATCOMs is suggested by Zarghami. Integration of D-STATCOM and battery energy storage is given by Zhang . Application study of a D-STATCOM with energy storage is presented by Arulampalam . Energy storage for power flow management and voltage control on an 11 kV UK distribution network is suggested by Svensson . Control of full-scale converter based wind power plants for damping of low frequency system oscillations is given by Adamczyk. On power-system benefits, main-circuit design, control of D-STATCOMs with energy storage is presented by Xie.

Power System Stability and Control is suggested by Kundur. Power system stability improvement by energy storage type D-STATCOM is given by Matsumura. Bulk power system low frequency oscillation suppression by FACTS/ESS is presented by Zhang . Power converter and SMES in controlling power system dynamics suggested by Ribeiro . A fast estimation algorithm for low-frequency, An oscillation in power systems is given by Bongiorno . Control of energy storage equipped shunt-connected converter for electric power system stability enhancement is presented by Beza . Auto-normalizing phase-locked loop for grid-connected converters is suggested by Bongiorno . Voltage collapse in power systems is presented by Gustafsson.

II. SIMULATION RESULTS

Circuit model without D-STATCOM is shown in Fig 2.1. The load voltage at bus two shown in Fig 2.2 and its peak value is 1.1KV. The real power and reactive power in Bus two are shown in Fig 2.3 and its value of real power 11KW and reactive power is 7KVAR. The load voltage bus in eleven is shown in Fig 2.4 and its peak value is 1KV. The real power and reactive power in bus eleven is shown in Fig 2.5 and the value of real power is 5.5KW and reactive power is 5KVAR.

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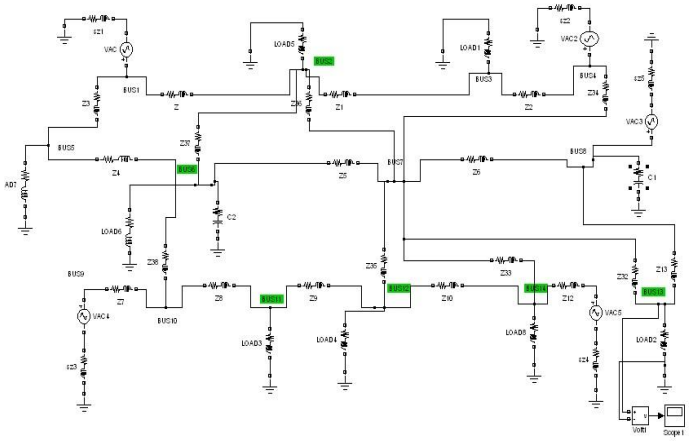

Fig 2.1 Circuit Model without D-STATCOM

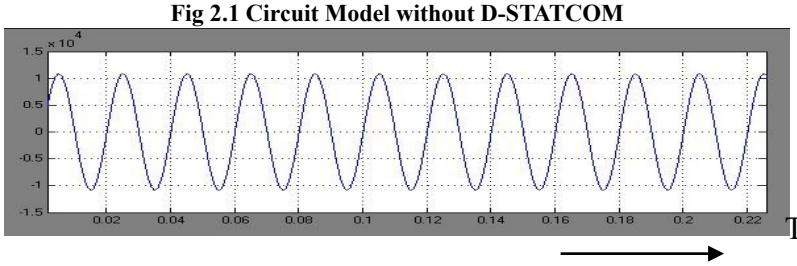

Fig 2.2 Voltage at Bus Two

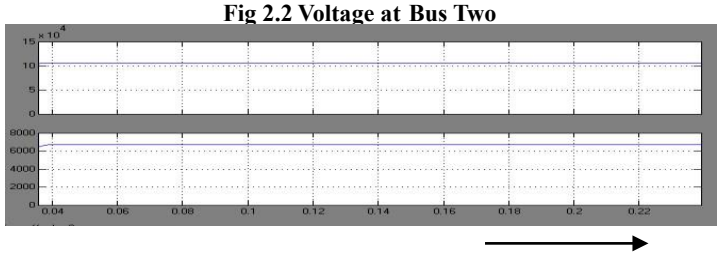

Fig 2.3 Real and Reactive Power at Bus Two

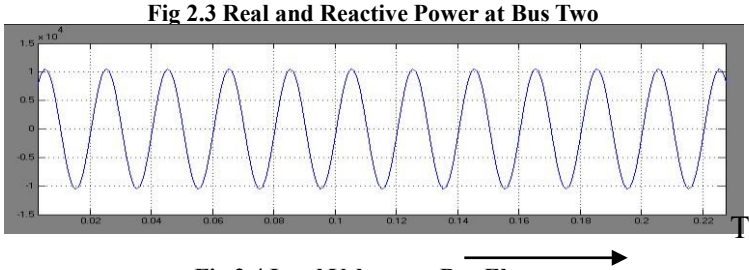

Fig 2.4 Load Voltage at Bus Eleven

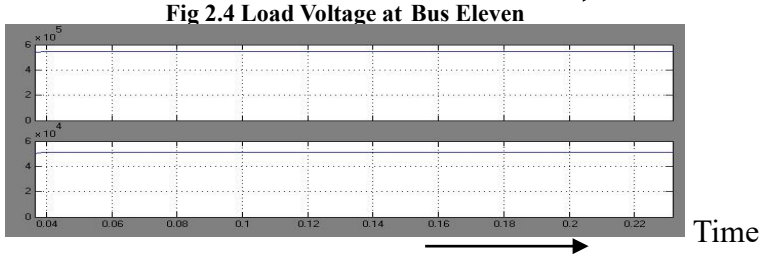

Fig 2.5 Real and Reactive Power at Bus Eleven

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III. THREE LEVEL D-STATCOM

The Circuit with three level D-STATCOM is shown in Fig 3.1. Three level inverter system is shown in Fig 3.2. Load voltage in bus two is shown in Fig 3.3 and its peak value is 1KV. The real power and reactive power at bus two are shown in Fig 3.4. The value of real power is 3.5KW and reactive power is 5KVAR.The load voltage at bus eleven is shown in Fig 4.5 and its peak value is 0.8KV. The real power and reactive power in bus eleven are shown in Fig 3.6 and value of real power is 5.5KW and reactive power is 5KVAR. The FFT analysis is shown in Fig 3.7. The THD

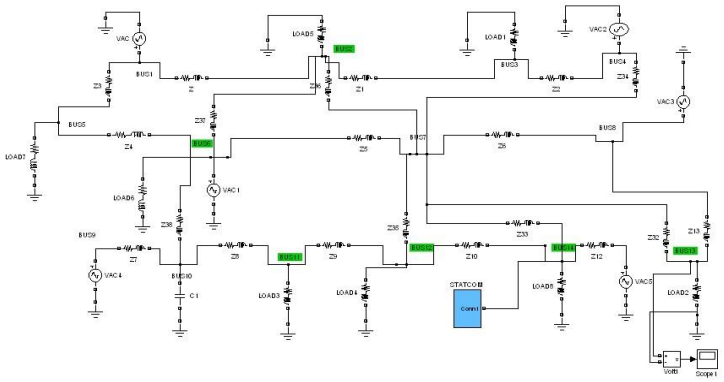

Fig 3.1 Circuit Model of Fourteen bus system with D-STATCOM

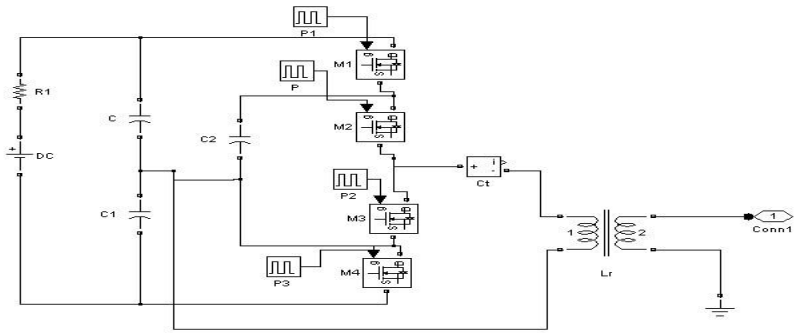

Fig 3.2 Three Level Inverter

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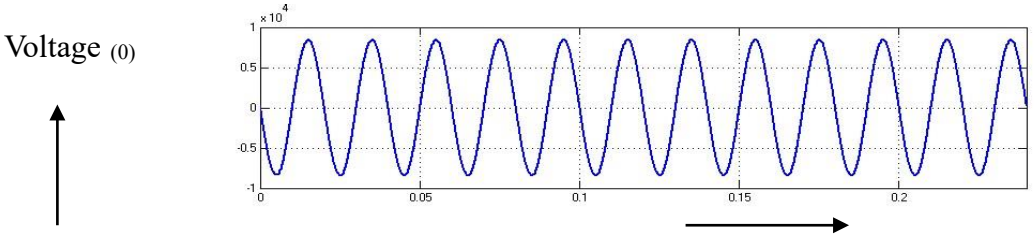

Fig 3.3 Voltage at Bus Two

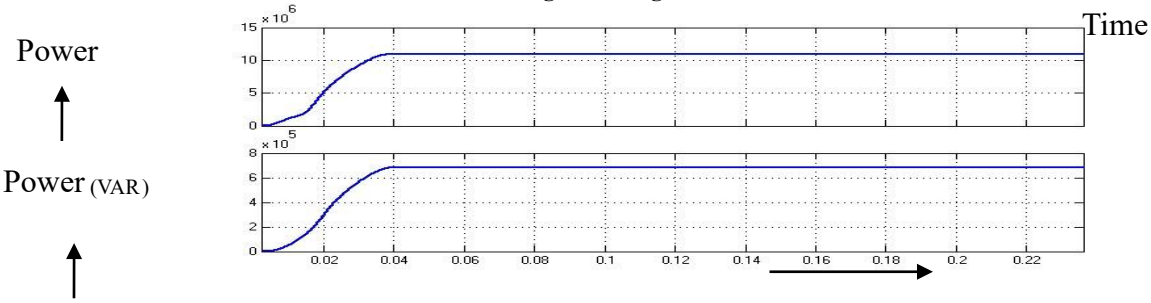

Fig 3.4 Real and Reactive Power at Bus Two

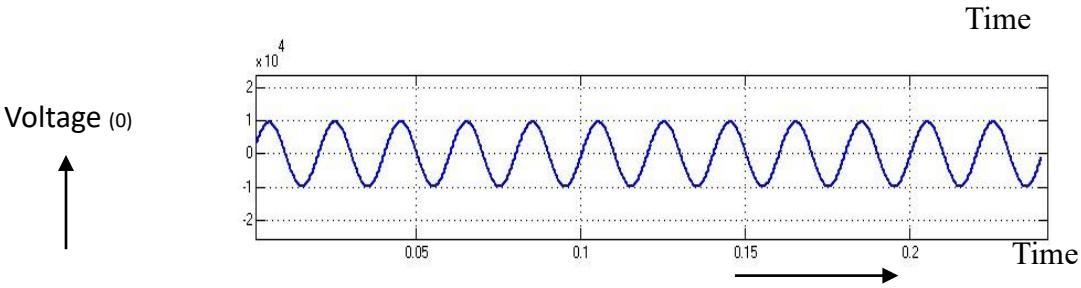

Fig 3.5 Voltage at Bus Eleven

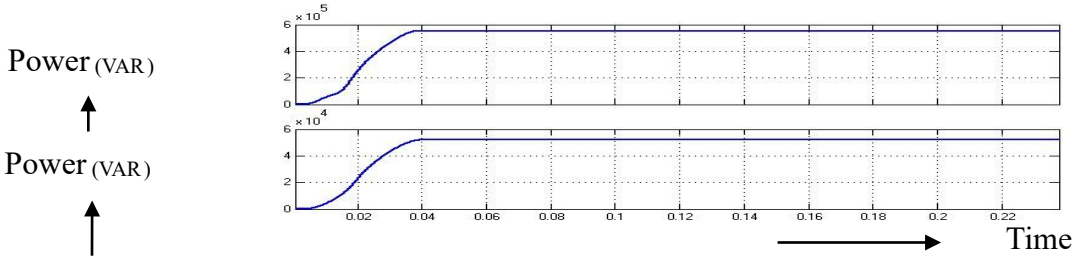

Fig 3.6 Real and Reactive Power at Bus Eleven

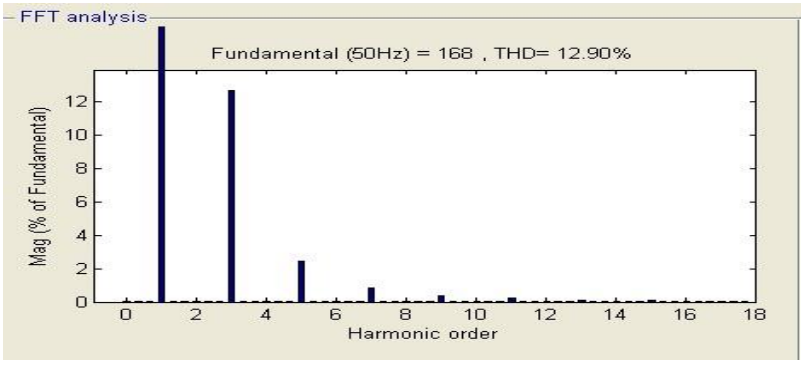

Fig 3.7 THD

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IV. SEVEN LEVEL D-STATCOM

The Circuit with seven level D-STATCOM system is shown in Fig 4.1. The seven level inverter system is shown in Fig 4.2. The load voltage in bus two is shown in Fig 4.3 and its peak value is 1KV. The real power and reactive power is shown in Fig 4.4 and its value of real power is 11KW and reactive power is 7KVAR. The load voltage in bus eleven is shown in Fig 4.5 and its peak value is 1KV. The real power and reactive power are shown in Fig 4.6 and the value of real power is 5.5KW and reactive is 5KVAR. The THD is shown in Fig 4.7.

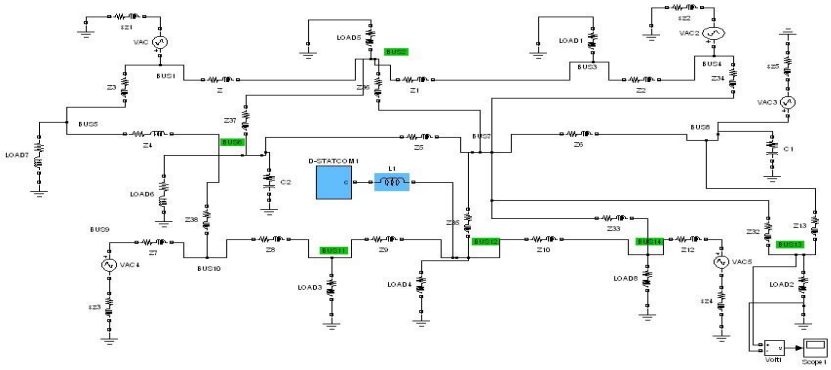

Fig 4.1 Circuit Model With D-STATCOM

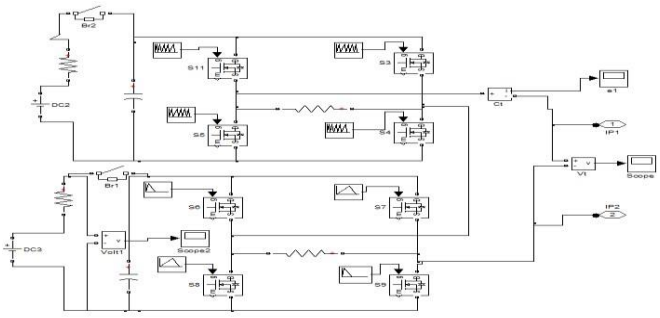

Fig 4.2 Seven Level Inverter

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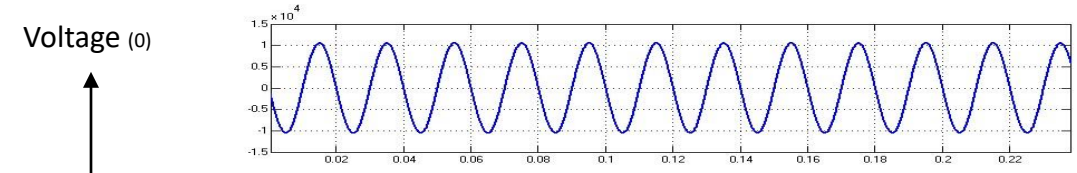

Fig 4.3 Voltage at Bus 2

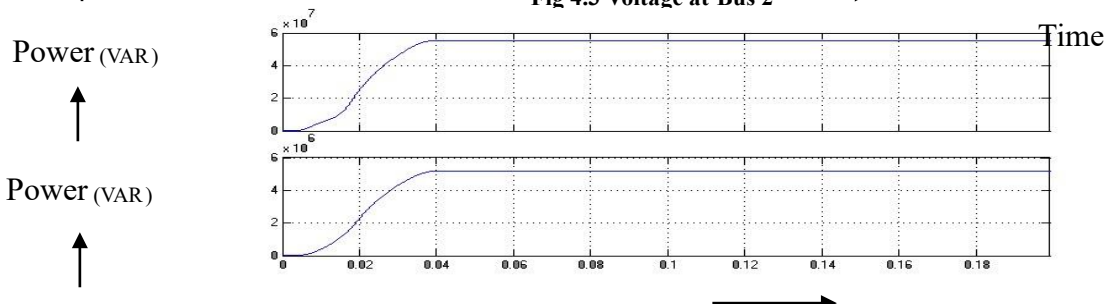

Fig 4.4 Real and Reactive Power at Bus Two

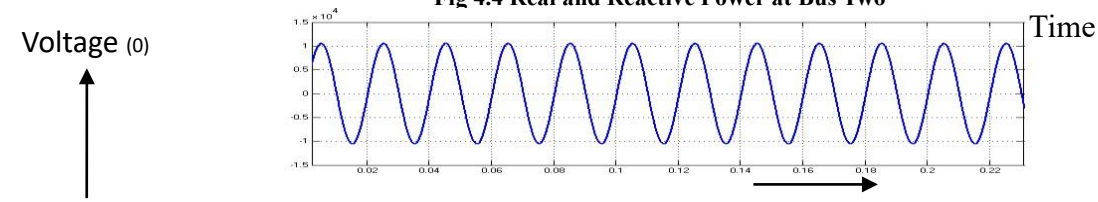

Fig 4.5 Load Voltage at Bus Eleven

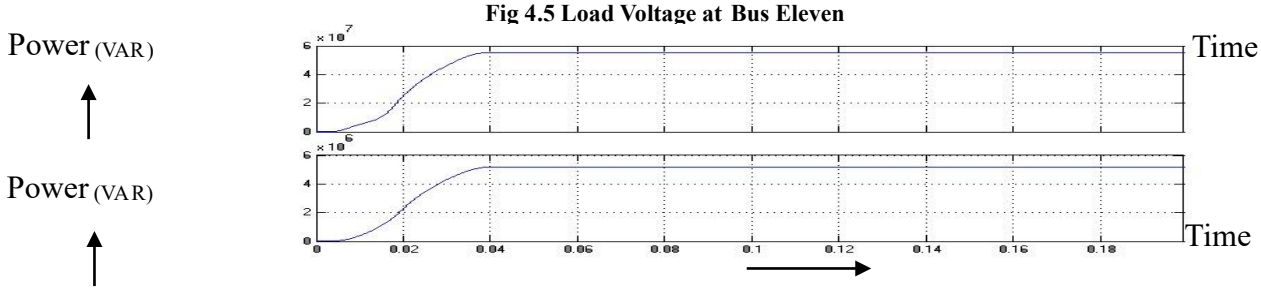

Fig 4.6 Real And Reactive Power In Bus Eleven

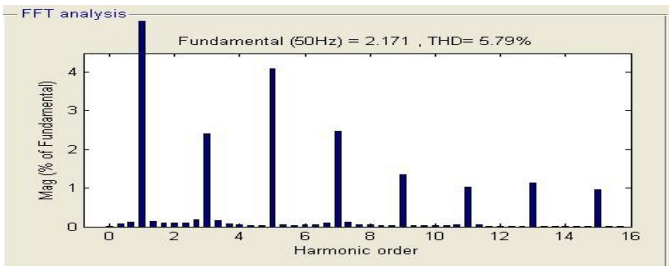

Fig 4.7 THD

The comparison of real power and reactive power

The comparison of real power and reactive power is shown in Table-1. The variation of reactive power is shown in Fig 5.1 Voltages at various buses are summarized in Fig 5.2.The comparison of Current THD is given in Table-2. The THD with seven level inverter is reduced to 5.7%.

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Table -1 Comaprision Of Real & Reactive Powers

Bus No	Q (Mvar) Without D-STATCOM	Q (Mvar) With D-STATCOM	Voltage (Kv) Without D-STATCOM	Voltage (Kv) With D-STATCOM
2	0.015	0.092	8456	9821
6	0.026	0.086	8238	8798
11	0.058	0.563	7586	8214
12	0.012	0.694	7218	8697
13	0.034	0.456	7468	8878
14	0.058	0.427	7748	8567

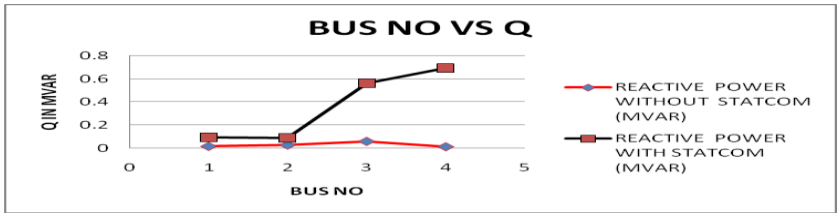

Fig 5.1 Variation of Reactive power

Fig 5.2 Profile of bus voltage

Table -2 Comaprision Of Current THD

D-STATCOM	Thd

Three Level	12.90%
Seven Level Inverter	5.79%

V. CONCLUSION

Fourteen bus systems with three level and seven level based D-STATCOMs were simulated successfully using Matlab. Transmission line was represented by series impedance and loads were represented by shunt impedance models. Frequency Spectrum indicates that THD of seven level DSTATCOM is 7% less than that of three level D-STATCOM.

The present work deals with comparison of D-STATCOM in fourteen bus system. These studies can be extended for thirty bus system. The use of multiple D-STATCOMs can be investigated in future. Closed loop controlled systems can be investigated in future.

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