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Improvement Of Statcom With Grid Connected Flicker Minimization And Power Quality Improvement

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***Abstract*- The injection of the PV Grid power into an electric grid affects the power quality. The influence of the PV Grid in the grid system concerning the power quality measurements and the norms followed according to the guidelines specified in the International Electro technical Commission standard, are the active and reactive power variations, variation of voltages, flicker, harmonics and electrical behavior of switching operations. The work study demonstrates has overall good functional characteristics, better performance and faster response than existing systems. The proposed system of having STATCOM is smaller in size and less costly when compared to the existing system. In this proposed system static compensator (STATCOM) is connected at a point with a battery energy storage system to reduce the power quality issues. The effectiveness of the proposed scheme gives the reactive power demand of load and the induction generator. Simulation is done by using MATLAB / SIMULINK-Sim power system software.**

***Keywords*-International electro-technical commission (IEC), power quality.**

I. INTRODUCTION

Power system is generally dealt with in terms of power generation, transmission and distribution. Usually, power generating plants are located far away from the load centres because of environmental, economic and safety reasons. Transmission lines are operated at high or extra high voltages to reduce losses during transmission. Modern power systems have many interconnections to exploit diversity of loads and to ensure reliability of supply. Performance of power system depends on the dynamics of system components at different levels like generators, transmission lines, loads, protective devices.

AC power systems play a major role in transmission in most of the countries. Power system stability, which is essential for efficient power transfer, is mainly concerned with steady state stability and transient stability. Steady state stability is concerned with flow of power under relatively slow or gradual change in the load. Transient stability is concerned with the maximum flow of power possible through a point without affecting stability when sudden and large changes in the network conditions like faults and load changes occur. Conventional methods to ensure stability are to use synchronous generators, shunt compensation, series compensation and transmission angle control.

II.ELECTRICAL GRID

Electrical grid contains the generating station which generates electrical power and it transmits the power from the distant sources to the demand points by means of high voltage transmission lines. The distribution lines are connected to individual consumers. Grid is an interconnected system for consuming the electric power from the suppliers to consumers. Usually, power stations are located near renewable energy sources, at a dam site, or a fuel source. The electric power is produced, and the voltage level is increased by stepped it up and then it was connected with the electric power transmission network.

III. MOTIVATION AND OBJECTIVE

Statcom is described by dynamic equations which are nonlinear with terms involving product of functions of control inputs and state variables. But the controllers used are usually linear. To design a control system for Statcom, it is preferable that its dynamic equations are first linearized by any of the linearization methods.

IV. LITERATURE REVIEW

Agashe Neha M., R D. Kulkarni, A. R. Thorat "Power Flow Study and Analysis using STATCOM" STATCOM is Flexible AC Transmission System (FACTS) device which can be used to maintain the voltage profile at the bus in the power system. This paper has discussed the STATCOM operation and it's V-I characteristics. In this paper the power flow is calculated with STATCOM with the help of iterative Newton-Raphson method. Six bus system is considered to validate the results obtained and they are presented with and without use of STATCOM in the system. Ajinkya Pachghare, R.M.Sahare, and "Voltage Regulation and Reactive Power Compensation by STATCOM based on 48-Pluse GTO (VSC): In this paper

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we presented STATCOM based on 48-pulse GTO for reactive power compensation and voltage regulation. Here we propose to tackle the existing problem in power transmission systems with multiple controller systems. The comprising a 48-pulse GTO(Gate Turn-Off) thyristor voltage source converter for combined reactive power compensation and voltage regulation of the electric grid network.

V. PROPOSED METHODOLOGY IN STATCOM PROPOSED METHODOLOGY-SELF MODIFYING STATCOM

A STATCOM is one of the famous and important members of the FACT family. It has a very special ability to absorb reactive power and provide reactive power, and again absorbing real power in and providing real power out of the system. The STACOM is a shunt compensated device. the STATCOM can provide 3-phase controlled waves of Various parameters like the phase angle, frequency, voltage magnitude etc. it is actually a kind of a solid state switching device which have the capability to generate and accept real power and reactive power independently .

Here the STATCOM has the heart of the device is the VSI that is the voltage source inverter. A static capacitor is used to provide the constant dc voltage supply to the STATCOMs voltage source inverter. The STATCOMs outer terminal is connected through a leakage reactance to the system or the main voltage bus that is to be connected. And here we have the constant power of the dc voltage is being supplied by the chosen well designed capacitor which can give a constant dc voltage to the VSI terminal of the STATCOM. The unique ability of the STATCOM to absorb the reactive power and the real power when needed with the fast response makes it a special device. Here we can look for the STATCOM for the following purposes as listed below,

1. To control of the dynamic voltage in a power system and in distribution system
2. Used to treat during the power oscillation damping condition
3. The device can be also be utilized to treat the transient stability of the power system
4. Sometime the voltage flickering control can be easily be done through IT
5. The uniqueness in the STATCOM is that it can exchange both active power and reactive power with the system with a connected line exchange with the dc energy system
6. The STATCOM can be considered a very similar device just as it is a synchronous machine.
7. Both have the same tendency to generate 3-phase electrical power with the given controlled frequency, phase angle and the magnitude of the fundamental voltage. They both can generate the reactive power and active power for the system. But one of main difference between them the STATCOM can provide the electrical power exchange for the small period of time but the synchronous machine can generate continuously for the given system .So, the above point shown the utility of the STATCOM circuit.

The Operation Principle

The operation principle of the STATCOM is very simple. It has to provide the given amount of the reactive power when needed and absorb the active power or reactive power when needed accordingly. The exchange of the power between the STATCOM and the device ac system is purely an electronic exchange system. The heart of the STATCOM lies in a VSC (voltage source converter). It is where the reactive power for the system is being generated. Not inside the capacitor where the reactive power is generated.

STATCOM is purely a compact device and very effective in nature. Its power electronics equipment inters connects between each other and they generate the required reactive energy for the exchange with the reactive system. Its unique ability to provide leading VAR and accepting the lagging VAR from the system makes it stand aside. This obviates the requirement of the reactor or capacitance heavy banks with a simple compact power electronics module can be neglected. The main exchange of the energy between the system and the STATCOM can be carried out by the changing the voltage magnitude and the phase angle of the output of the STATCOM of the system.

VI. RESULT AND DISCUSSION

It has a capability to cancel out the harmonic parts of the load current. It maintains the source voltage and current in-phase and support the reactive power demand for the solar panel and load at in the grid system, thus it gives an opportunity to enhance the utilization factor of transmission line. The integrated grid and STATCOM with solar have shown the outstanding performance.

Matlab Modelling

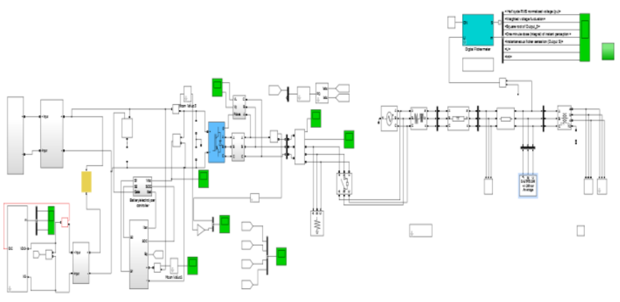

Fig. 1 Grid connected STATCOM.

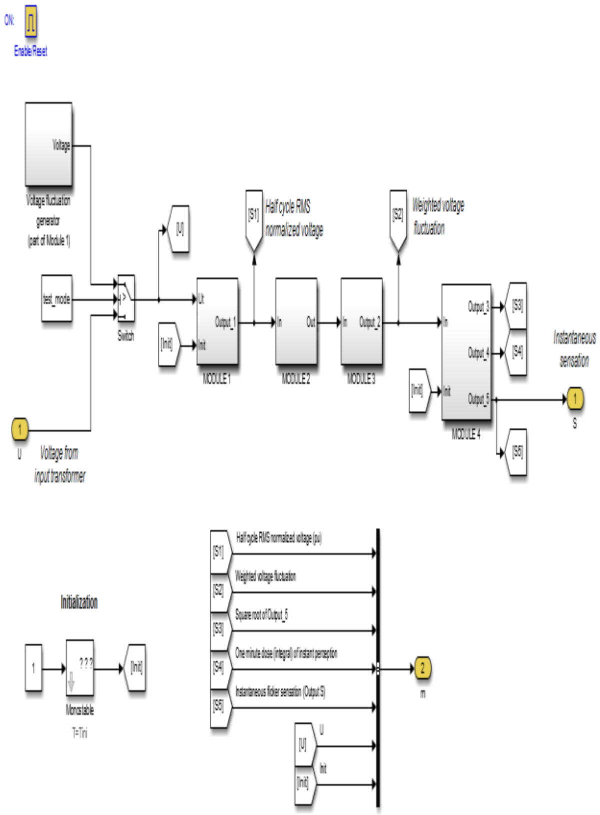

Fig. 2 STATCOM Flicker generator.

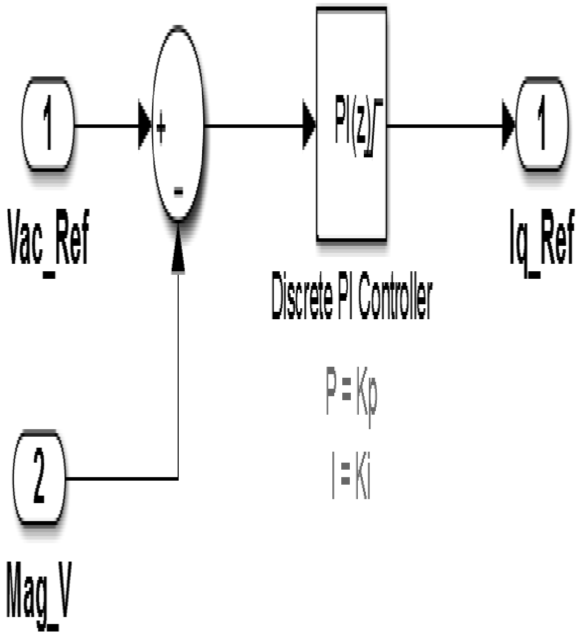

Fig. 4 STATCOM PI Controller

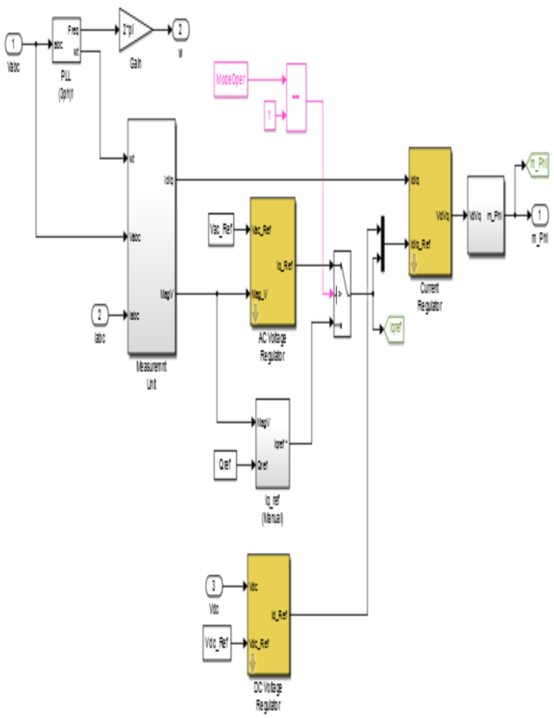

Fig. 3 STATCOM Controller.

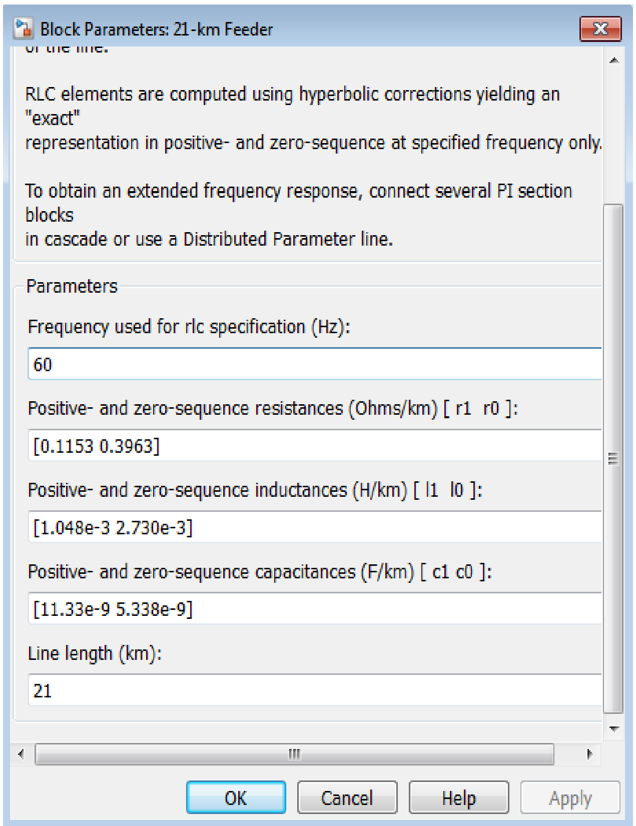

Fig. 6.5 Transmission line.

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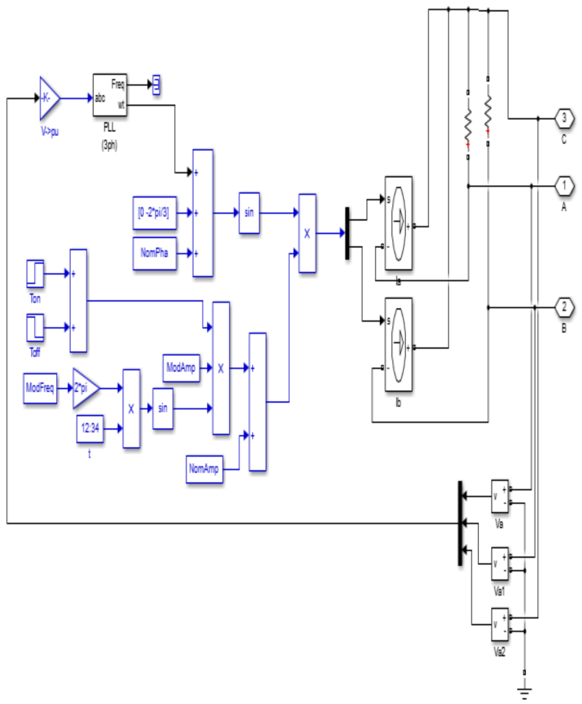

Fig. 6 Variable load Generator.

Matlab Modelling Outcomes

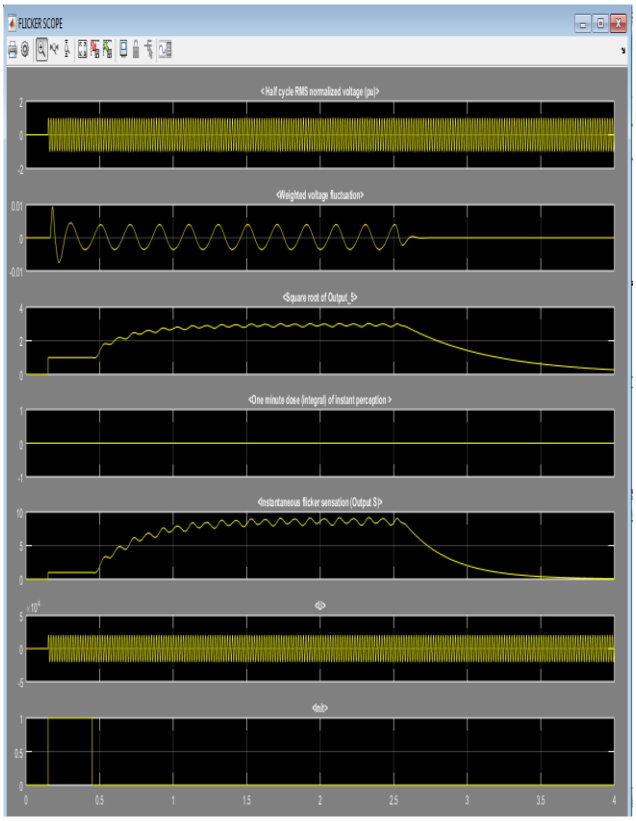

Fig. 7 RMS normalized voltage, voltage fluctuation, Square root outcomes, integral outcomes, flicker sensation outcomes, power and control pulse.

Fig.7 (a) shows as X axis is time and Y axis is Amplitude of RMS normalized voltage. These are show variation of voltage with respect to time.

Fig.7 (b) shows as X axis is time and Y axis is Amplitude of voltage fluctuation. These are show variation of voltage fluctuation with respect to time.

Fig.7 (c) shows as X axis is time and Y axis is Amplitude of Square root outcomes. These are show variation of Square root outcomes with respect to time.

Fig.7 (d) shows as X axis is time and Y axis is Amplitude of integral outcomes. These are show variation of integral outcomes with respect to time.

Fig.7 (e) shows as X axis is time and Y axis is Amplitude of flicker sensation outcomes. These are show variation of flicker sensation outcomes with respect to time.

Fig.7 (f) shows as X axis is time and Y axis is Amplitude of power. These are show variation of power with respect to time.

Fig.7 (g) shows as X axis is time and Y axis is Amplitude of control pulse. These are show variation of control pulse with respect to time.

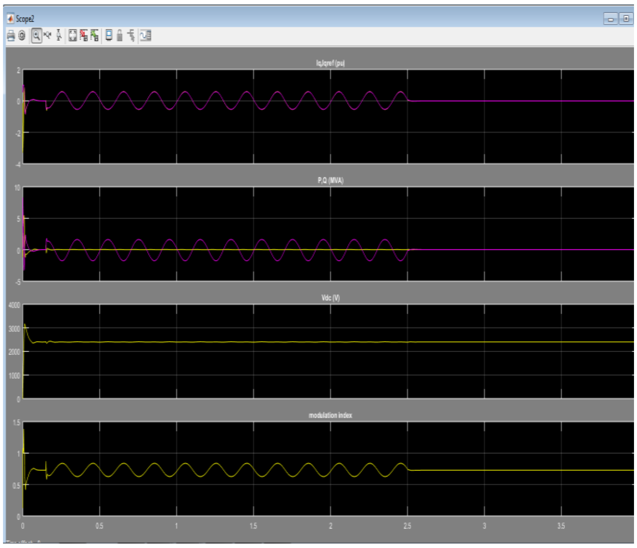

Fig. 8 Reference current, P&Q power, regulating voltage and modulation index.

Fig.8 (a) shows as X axis is time and Y axis is Amplitude of Reference current. These are show variation of Reference current with respect to time.

Fig.8 (b) shows as X axis is time and Y axis is Amplitude of P&Q power. These are show variation of P&Q power with respect to time.

Fig.8 (c) shows as X axis is time and Y axis is Amplitude of regulating voltage. These are show variation of regulating voltage with respect to time.

Fig.8 (d) shows as X axis is time and Y axis is Amplitude of modulation index. These are show variat ion of modulation index with respect to time.

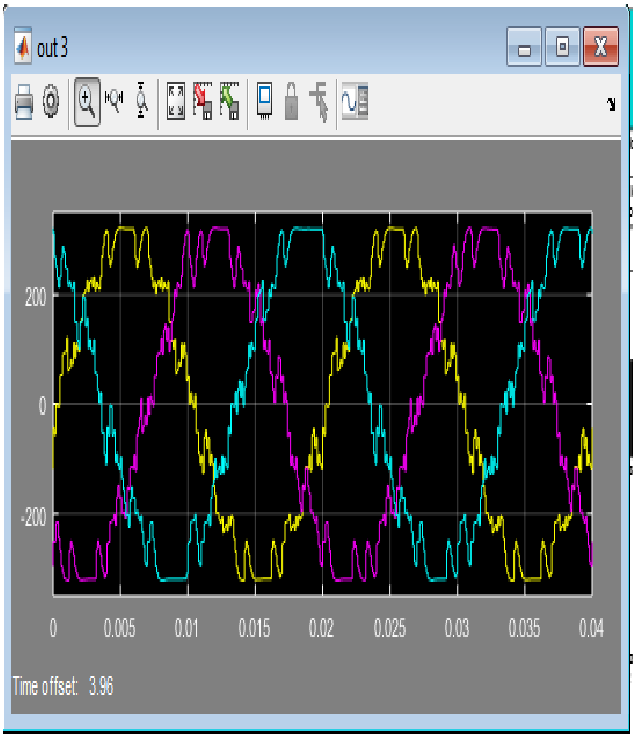

Fig. 9 Grid side Voltage.

Fig.9 shows as X axis is time and Y axis is Amplitude of Grid side Voltage. These are show variation of Grid side Voltage with respect to time.

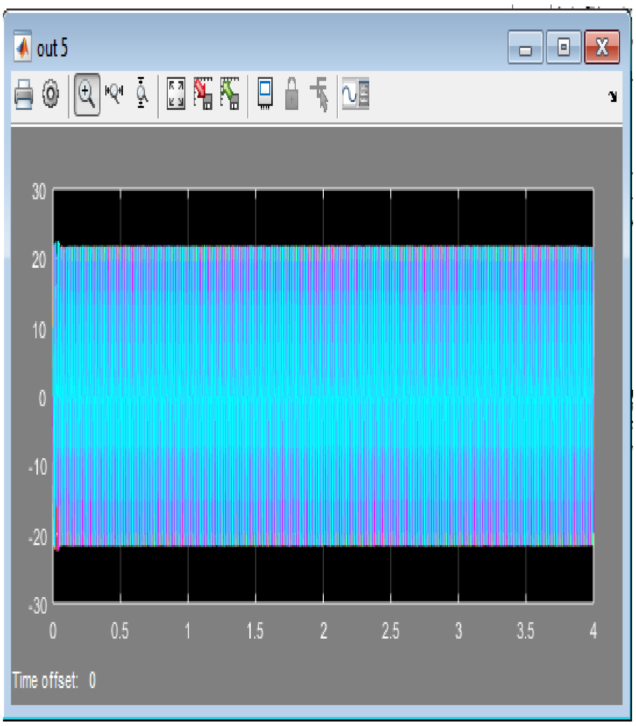

Fig. 10 Grid side Current.

Fig.10 shows as X axis is time and Y axis is Amplitude of Grid side Current. These are show variation of Grid side Current with respect to time.

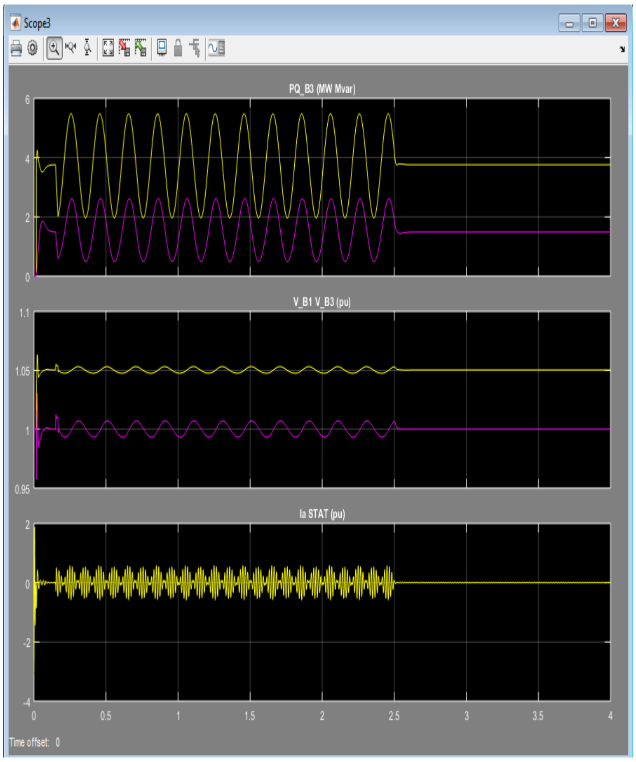

Fig. 11 P&Q (MW) power, Bus across voltage and per unit voltage stability index.

Fig.11 (a) shows as X axis is time and Y axis is Amplitude of P&Q (MW) power. These are show variation of P&Q (MW) power with respect to time.
Fig.11 (b) shows as X axis is time and Y axis is Amplitude of Bus across voltage. These are show variation of Bus across voltage with respect to time.
Fig.11 (c) shows as X axis is time and Y axis is Amplitude of per unit voltage stability index. These are show variation of per unit voltage stability index with respect to time.

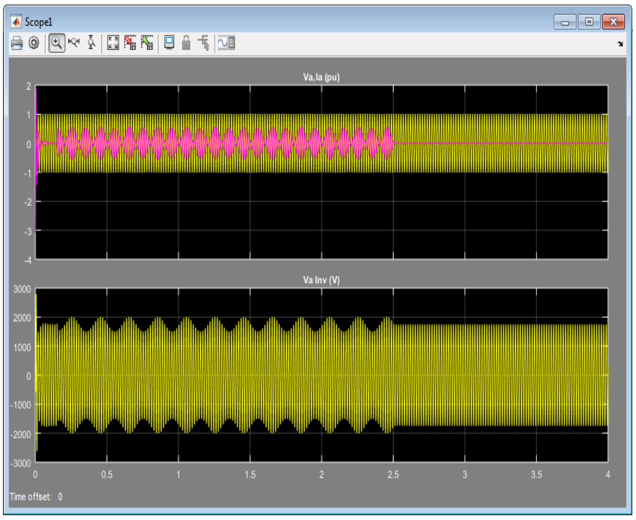

Fig. 12 Compensating voltage & current, inverter across voltage.

Fig.12 (a) shows as X axis is time and Y axis is Amplitude of Compensating voltage & current. These are show variation of Compensating voltage & current with respect to time.

Fig.12 (b) shows as X axis is time and Y axis is Amplitude of inverter across voltage. These are show variation of inverter across voltage with respect to time.

VII. CONCLUSION

In this work, the performance of based STATCOM supported by DC link capacitor has been examined and implemented using STATCOM theory. Contrasted to their solitary performance, DC link capacitor with inverter provides better neutral current and grid current compensation and also reduced the filters requirement. The suggested control strategy on the 5.8MW distribution system having Solar STATCOM System with a capacity of has been modeled and validated for its satisfactory working condition and came up with better harmonic relief at the power and grid side. The Sim-power components in MATLAB/SIMULINK software environment is used to obtain the simulation results.

Scope of Future Work

The FACTS devices can enhance the power transmission capability, reactive power compensation, improvement of power quality, and increase the stability of the power system network. This presents optimal power flow (OPF) solution consists of reduction of fuel cost as the objective function. Here we are using STATCOM among all the available shunt FACTS devices to improve the power transfer capability of the line. Particle swarm optimization technique (PSO) is used for optimal power generation with inclusion of STATCOM and for base case. Active power loss, reactive power loss and L-index are calculated. The effectiveness of this method is tested on IEEE-30 bus data consists of 6 generator buses using MATLAB programming.

REFERENCES

[1] F. Katiraei and J. R. Aguero, "Solar PV Integration Challenges," in IEEE Power and Energy Magazine, vol. 9, no. 3, pp. 62-71, May-June 2011.

[2] Obi, Manasseh, and Robert Bass. "Trends and challenges of grid-connected photovoltaic systems–A review." Renewable and Sustainable Energy Reviews 58 (2016): 1082-1094.

[3] D. Cheng, B. A. Mather, R. Seguin, J. Hambrick, and R. P. Broadwater, "Photovoltaic (PV) impact assessment for very high penetration levels," IEEE Journal of Photovoltaics, vol. 6, pp. 295-300, 2016.

[4] "High-Penetration PV Integration Handbook for Distribution Engineers", Technical Report NREL/TP-5D00-63114 January 2016

[5] N. J. Bravo, R. Salas, T. Bialek, and C. Sun, "Distributed energy resources challenges for utilities," Proc. 2015 IEEE 42nd Photovoltaic Specialist Conference, PVSC 2015, 2015.

[6] Jeff Smith and Matt Rylander, "PV Hosting Capcity on Distribution Feeders", Proc. 2014 IEEE PES GM, Washington, USA, 2014

[7] SJ Steffel, PR Caroselli, AM Dinkel, JQ Liu, RN Sackey, and NR Vadhar, "Integrating solar generation on the electric distribution grid," IEEE Transactions on Smart Grid,, vol. 3, pp. 878-886, 2012

[8] Y. Kabasawa, T. Noda, K. Fukushima and K. Nemoto, "Consumer voltage regulation using coordinated control of distributed static synchronous compensators - STATCOMs," in Proc. 2012 3rd IEEE PES Innovative Smart Grid Technologies Europe, pp. 1-7.

[9] N. G. Hingorani and L. Gyugyi, Understanding FACTS, New York: IEEEWiley, 1999.

[10] "System Impact Assessment Report – Grand Renewable Energy Park Project" Independent Electricity System Operator (IESO) Report No. CAA ID 2010-399, May 2011.