iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** II **Month of publication:** February 2018

DOI: http://doi.org/10.22214/ijraset.2018.2009

A Smart Series Reactive Voltage Regulator Integrated with Renewable Energy Sources for Low Power Application

Durgesh Prasad Bagarty[1], Tapas Kumar Patra[2], Sribatsa Behera[3]
[1] *Asst. Prof, Electrical Engg Dept*
[2, 3] *Asst. Prof and Professor, Instrumentation and Electronics Engg Dept, College of Engineering and Technology, Bhubaneswar*

Abstract: Voltage fluctuation and possibility of frequent disruptions are usually situations associated with electrical network. The same situation could be prominent while it is dealt with renewable energy sources (wind power, solar energy etc). Because of their intermittent in irradiance of solar energy and inconsistent wind flow, the generated voltage at load is also fluctuating in nature. Since the electrical appliances connected to load side are sensitive to voltage, so it requires the voltage needs to be regulated because of sensitivity of load devices. In this paper, a fast PWM-based Smart Series Reactive Voltage Compensator (SSRVC) has been modelled and simulated under a Sliding-Mode Controller (SMC) to investigate its performance and the relevant results are presented.
Keywords:- Smart Series Reactive Voltage Compensator, Sine PWM Technique, Sliding Mode Controller, Matlab/Simulink

I. INTRODUCTION

Mostly the growth of any nations is fully dependent upon electricity. When majority population of world the resides in rural area, but their daily lives are highly influenced due to lack of good infrastructure and energy requirement. Because of disseminating of fossil fuel, the attention has been focused upon renewable energy resources. Though the prominent renewable resources are wind and solar power, but the solar energy overweigh over wind energy in many aspects because of their available abundantly during major period of the year around the world. So lack of energy leads to the poor growth in industrialization and unemployment issue. Hence this issue can be addressed by providing cheap energy to rural area, where conventional energy cannot reach because of technical problems. So under this situation the renewable energy is an best option. But it needs proper optimization and control mechanism for best utility in energy requirement with the help of smart technology.

Keeping all facts in mind, now it is high time to think up for common people residing in rural area to provide them reliable, cheap electricity with smart technology for their optimization and proper utilization. Also the portability is the another issue which can be thought up in terms of light weight so as to make the system easier transportable under the situation like natural calamities.

The research studies associated with power quality include the quality of voltage supply with respect to temporary interruptions, voltage dips, harmonics, and voltage flicker [1]. So these are the most common and important problems which are affecting low and medium voltage customers. The voltage sags, [2,3] which are usually associated with faults in the power grid, can also be caused due to transient nature in switching of heavy loads. So the power quality is strictly related to the economic consequences and associated with the equipment considering the customers point of view[2]. So there is a need for solutions which must be dedicated to customers with highly sensitive loads. Further it needs to synthesize the characteristics of voltage sags both in domestic and industrial distributions so as to make fast acting voltage regulator. In order to face this challenge, there needs a device capable of injecting minimum energy [4-7] so as to regulate load voltage at its predetermined value.

Various control strategies have been developed to mitigate the unbalanced voltage sag/swell [8-10] and the mitigation of unbalanced voltage dips using SSC(Static series compensator) under harmonic voltage reduction [9&11]. A generalized voltage swell and over voltage compensation strategy for mitigating the impacts of voltage sag/swells has been investigated [12]. In order to improve performances, the authors [13-16] have considered the use of fuzzy logic control for improvement of power quality, harmonic minimization and frequency control.

A new concept “Electric Spring” as Smart Grid Technology has been put forth [17] and its stabilizing for future grid has been min concern by the authors in [18]. The energy storage requirement for operation in case of smart grid has been minimized by the authors [19]. The modelling and steady state analysis electric spring in case of smart grid is investigated in [20 & 22], whereas the power factor correction is implemented [21]. Also it has been decoupled the voltage and power angle control for smart grid [23]. This paper presents the digital modelling and simulation of a sliding mode control[24] of a Smart Static Series Reactive Voltage Compensator (SSRVC). So it has been carried out with the help of the MATLAB/Simulink Power System Blockset (PSB) under sudden dip in load voltage. The mathematical model and instantaneous current control strategy are explained and discussed. The capability of the series compensator to mitigate the voltage dip is demonstrated by digital simulation. .

II. BASIC STRUCTURE OF STATIC SERIES REACTIVE VOLTAGE COMPENSATOR (SSRVC)

The basic elements of a SSRVC (i.e., shown Fig.1) are dc side energy source, voltage source converter, injection series transformer and harmonic filter. The details about these components are described as follows.

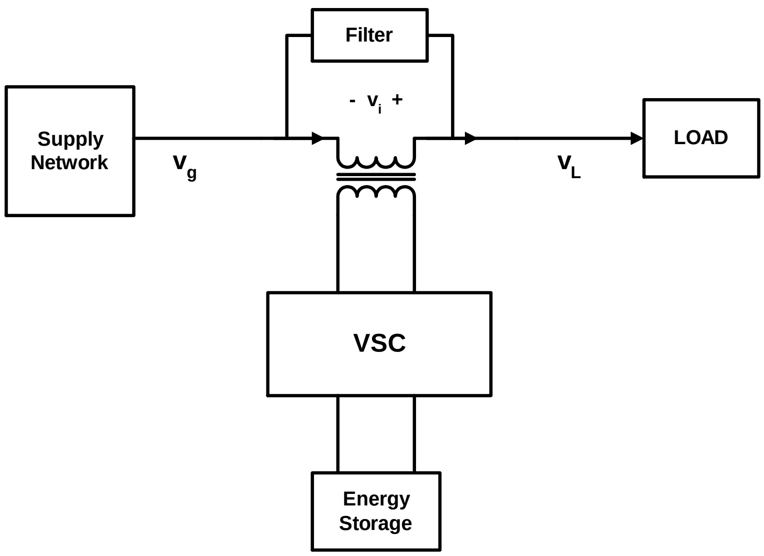


Fig.1: Basic Structure of Series Reactive Voltage Compensator

A. *Energy Source on DC side and Voltage Source Converter*

The energy storage devices are dc capacitors, batteries, super conducting magnetic storage of Static Series Reactive Voltage Compensator (SSRVC). This energy can be tapped from dc battery or renewable energy resources at a constant voltage level. The present work employs dc capacitor banks. The rating of dc side capacitor has been chosen considering the voltage dip without phase angle jump. The size of capacitors should be chosen such that during dip of maximum expected magnitude and duration, the load voltage is kept at rated value and dc voltage does not decrease below a minimum allowable selected value [16]. In case of voltage sag V_{dip} (pu) with no phase angle jump, the series compensator should inject an active power in order to restore the pre-dip rated voltage V_{lr} at the load terminals and this active power is given by

$$P_{SSRVC} = -v_{dc}\, i_{dc} = -C_{dc} v_{dc} \frac{dv_{dc}}{dt} = V_{lr}\, I_{lr} \cos\phi_{lr}\ (1 - V_{dip}) = P_{lr}\ (1 - V_{dip}) \tag{1}$$

where the load current I_l and power factor cos Φ_r are assumed to be constant and equal to their rated value during dip compensation. P_{lr} is rated load power and v_{dc} is the dc voltage across the capacitor of dc side.

If t_{dip} is the voltage sag duration, the energy to be supplied by is

$$W_{SSRVC} = \int_{t_0}^{t_0+t_{dip}} P_{SSRPC}\ dt = \int_{t_0}^{t_0+t_{dip}} (-C_{dc} v_{dc} \frac{dv_{dc}}{dt})\, dt = \int_{t_0}^{t_0+t_{dip}} P_{lr}(1 - V_{dip})\, dt \tag{2}$$

This simplifies to

$$-\frac{1}{2} C_{dc} \left[v_{dc}^{\ 2}(t_0 + t_{dip}) - v_{dc}^{\ 2}(t_0) \right] = P_{lr}\,(1 - V_{dip}) \tag{3}$$

If $v_{dc}(t_o) = V_{dcr}$ (i.e., the initial dc link voltage is assumed at its rated value, and $v_{dc}(t_o+t_{dip}) = k_d V_{dcr}$, where $k_d V_{dcr}$ is the minimum allowable dc-link voltage at the end of voltage dip ($0 < k_d < 1$) to compensate a maximum voltage dip magnitude $V_{dip,max}$ for a maximum expected dip duration $t_{dip.max}$, then value of capacitance should be

$$C_{dc} \geq \frac{2P_{lr}\, t_{dip.\max}\,(1-V_{dip.\max})}{V_{dcr}^{\;2}(1-k_d^{\;2})} \tag{4}$$

The voltage rating of capacitor also limits the maximum injection voltage. The voltage source converter is controlled by a Pulse Width Modulation (PWM) technique. The magnitude of modulating signal is derived from control unit and this signal is then compared with fixed carrier signal to extract the signals of switching devices of converter. When the network is at its rated value, it is therefore possible to constrain the inverter to insert a voltage identically equal to zero by properly controlling semi-conductor components.

B. Series Injection Transformer

For the rating of transformer, the following considerations can be taken into account. In order to compensate a voltage dip of max depth $V_{i.max}(V_{gr})$ (i.e., $V_{i.max}$ (pu) <1) [16], the maximum series injection voltage and V_{gr} is the grid-rated line-to-line voltage), the transformer power is given by

$$A_t = V_{i.\max}\ V_{gr}\ I_{lr} \tag{5}$$

where I_{lr} is rated load current.

Since the voltage dips are short compared to thermal time constant of a transformer, it can be choosed the rated power that should be smaller than above calculated value. As well known, the RMS value of the fundamental frequency component $V_{c.1}$ of the SSRPC output phase voltage can be expressed as a function of PWM modulation index m_a (i.e., m_a <1) and of dc side voltage v_{dc}

$$V_{c.1} = m_a\ v_{dc} \big/ 2\sqrt{2} \tag{6}$$

Similarly

$$V_{c.1\max} = m_{ar}\ v_{dcr} \big/ 2\sqrt{2} \tag{7}$$

where mar modulation index at rated value.

As the series compensator has to compensate a voltage dip of max depth $V_{i.max}(V_{gr})$, the transformer turn ratio K_t can be determined

$$K_t = \frac{V_{i.\max}\ (V_{gr})}{V_{c1.\max}} = 2\sqrt{2}\ V_{gr}\ \frac{V_{i.\max}}{m_{ar}\ V_{dcr}} \tag{8}$$

The modulation index at rated value $m_{ar} = 0.75$ has been chosen in present work in order to operate in linear region when the maximum series injection voltage is required and to have still a compensation margin in the linear region for the voltage dips of larger depth or during compensation process, the dc side voltage falls below its rated value. A passive filter is needed for blocking the high-frequency harmonics generated by PWM switching. This filter can be connected either on converter side or on line side. In present case, an passive filter is considered on converter side and the cut-off frequency is decided based upon source frequency with additional 5%.

III.MODELLING OF SERIES COMPENSATOR

In present case, a complete control scheme will be defined for a series voltage compensator, which is connected to a linear load consisting of a resistance and inductance.

In order to study compensator connected in series with line as shown in Fig.1, the network can be simplified shown in Fig.2.

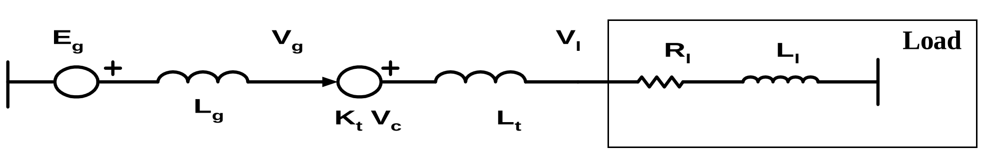


Fig. 2 Single phase equivalent circuit of the system under study

In this case, the voltage source converter [16] is considered as a voltage source with amplitude K_tV_c, L_t is leakage inductance of series transformer referred to network side. The source is represented by an ideal voltage source having amplitude E_g and inductance L_g. The voltage available before series compensator is V_g. The load is modeled as the series resistance R_l and an inductance L_l .

n order to set up an effective control system, it is first of all necessary to adequately model the system to be controlled.

To do this, the following hypotheses have been done.

The SSRPC is modelled as an ideal voltage source (i.e., with no delays)

$$L\frac{di_l}{dt}+R_l i_l(t)=v_g(t)+K_t\, v_c(t) \qquad L=L_t+L_l \tag{9}$$

$$v_l(t)=L_l\frac{di_l}{dt}+R_l\, i_l(t) \tag{10}$$

where $v_l(t)$: load phase voltage, $i_l(t)$: load phase current.

Applying Park's transformation to above two equations, one has following d-q equations from (9)

$$L\frac{di_{ld}}{dt}+R_l\, i_{ld}(t)-wL\, i_{lq}(t)=v_{gd}(t)+K_t\, v_{cd}(t) \tag{11}$$

$$L\frac{di_{lq}}{dt}+R_l\, i_{lq}(t)+wL\, i_{ld}(t)=v_{gq}(t)+K_t\, v_{cq}(t) \tag{12}$$

and from (10)

$$v_{ld}(t)=L_l\frac{di_{ld}}{dt}+R_l\, i_{ld}(t)-wL_l\, i_{lq}(t) \tag{13}$$

$$v_{lq}(t)=L_l\frac{di_{lq}}{dt}+R_l\, i_{lq}(t)+wL_l\, i_{ld}(t) \tag{14}$$

where 'w' is the system angular frequency and having indicated with x_d and x_q , the d- and q-axis components of each quantity.

A symmetrical voltage dip occurs at $t=t_0$ can be represented in this reference system with a step-variation of the network voltage $\Delta v_d(s)$; therefore, during the dip, the equations (11,12) can be rewritten in terms of variations with respect to pre-dip conditions, obtaining a system of ordinary differential equations, with initial conditions $\Delta i_{ld}(t_0) = \Delta i_{lq}(t_0) = 0$.

This allows to apply the Laplace Transform and write the following equations from (11,12).

(15)

$$sL\,\Delta i_{lq}(s)+R_l\Delta i_{lq}(s)+wL\Delta i_{ld}(s)=\Delta v_{gq}(s)+K_t\,\Delta v_{cq}(s) \tag{16}$$

and from (13,14)

$$\Delta v_{ld}(s) = sL_l\,\Delta i_{ld}(s)+R_l\Delta i_{ld}(s)-wL_l\Delta i_{lq}(s) \tag{17}$$

$$\Delta v_{lq}(s) = sL_l\,\Delta i_{lq}(s)+R_l\Delta i_{lq}(s)+wL_l\Delta i_{ld}(s) \tag{18}$$

After some algebraic manipulations, one easily gets from (15,16) and (17,18) as follows.

$$\Delta v_{ld}(s) = G(s)\left[\Delta v_{gd}(s)+K_t\,\Delta v_{cd}(s)+G_i(s)\Delta i_{lq}(s)\right] \tag{19}$$

$$\Delta v_{lq}(s) = G(s)\left[\Delta v_{gq}(s)+K_t\,\Delta v_{cq}(s)-G_i(s)\Delta i_{ld}(s)\right] \tag{20}$$

where $G(s)$ and $G_i(s)$ are defined as

$$G(s)=\frac{sL_l+R_l}{sL+R_l} \quad \text{and} \quad G_i(s)=\frac{wL_t\,R_l}{sL_l+R_l} \tag{21}$$

Hence defining the system

$$\Delta v'_{cd}(s) = \Delta v_{gd}(s)+K_t\,\Delta v_{cd}(s)+G_i(s)\Delta i_{lq}(s) \tag{22}$$

$$\Delta v'_{cq}(s) = \Delta v_{gq}(s)+K_t\,\Delta v_{cq}(s)-G_i(s)\Delta i_{ld}(s) \tag{23}$$

to be controlled is simply described by

$$\Delta v_{ld}(s)=G(s)\,\Delta v'_{cd}(s) \quad \text{and} \quad \Delta v_{lq}(s)=G(s)\,\Delta v'_{cq}(s) \tag{24}$$

The above pair of equations in (24) can be written as a single one.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887
Volume 6 Issue II February 2018- Available at www.ijraset.com

$$\Delta v_{ldq} = G(s)\, v'_{cdq}(s) \tag{25}$$

IV. SLIDING MODE CONTROL AND CONTROLLING MECHANISM

Sliding Mode Control is concerned with forcing one/more variable to follow a specific trajectory which is known as sliding surface [24]. The location of variables relative to sliding surface, which governs control law, is applied to the system. The starting point with sliding mode control is the definition of the sliding surface. For our objective, it is necessary to force the reference voltage to be same shape in phase with source voltage.

Therefore, the trajectory of line current is defined to be

$$V_{ld\text{-}ref}{}^{*} = k\, V_s \tag{26}$$

When the line current is on the sliding surface (S), the equation is written in standard form as

$$S = V_{ld\_Ref}{}^{*} - k\, V_s = 0 \tag{27}$$

The sliding mode controller under close loop operation is shown in Fig.3.

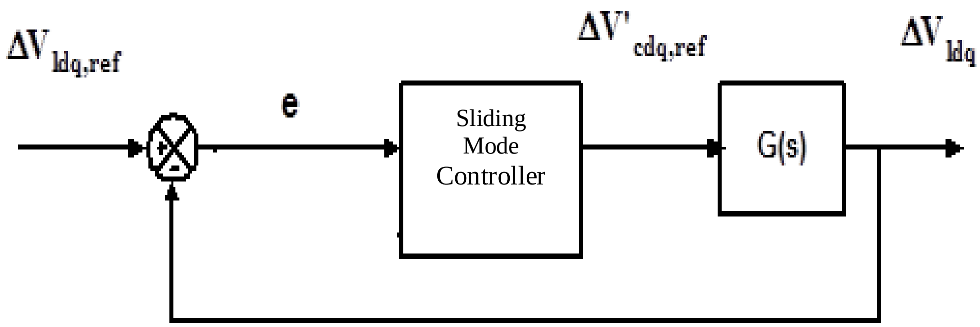


Fig. 3 Sliding Mode Control loop

V. SIMULATION RESULTS

A small prototype model of SSRVR connected to 1-phase utility has been considered and studied analytically with a Sliding Mode controller. The simulation of this model is carried out with MATLAB/Simulink. The results from simulation are presented in Figs. 4-7. Fig.4 shows the input voltage(V_{in}), injected voltage(V_{inj}), output current(I_o) and load voltage(V_o), where as Fig.5 shows load current(I_o) load voltage(V_o), input voltage(V_{in}), instant of activation for controller switch(sw-cl) and load switch(sw-ld) respectively.

In Fig.4 and 5, the input voltage is maintained at constant for duration 1 sec. The reference voltage is changed from 150 to 200 V at time 0.35 sec. The controller switch is activated at t=0.05 sec. It is observed that load voltage (V_0) sticks to 200 V when the reference voltage is changed at t=0.35 sec. Now the reference voltage is more than input voltage which is 150V. At t= 0.4 sec, the load switch is closed to increase load slightly, but it is observed that load voltage remains unaffected and settles at 200V. At t= 0.6 sec, the reference voltage is changed from 200V to 120V, which is less than input voltage without change in past load. So in first case, when reference voltage is increased 200 volt (i.e., more than input), the injected voltage is in phase with input voltage so as to maintain the reference voltage. Similarly when at time 0.6 sec, when reference voltage is brought from 200V to 120V. there is a phase opposition of injected voltage so as to maintain the reference voltage.

In Fig.6, it shows the step change in input voltage from 150 to 180V at time t=0.5 sec, whereas the reference voltage is maintained constant at 160V. The load is remained constant. Before step-change in input voltage, the reference voltage is more than input and after step-change in input voltage, the reference is less than input. This Fig shows that even if there is step change in input at 0.5 sec, the load voltage sticks to reference voltage.

Fig. 7 shows the harmonic analysis of load voltage under steady-state condition upto 500Hz. It shows that the Total Harmonic Distortion(THD) is around less than 4%, which is in permissible limit of IEEE standard.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887
Volume 6 Issue II February 2018- Available at www.ijraset.com

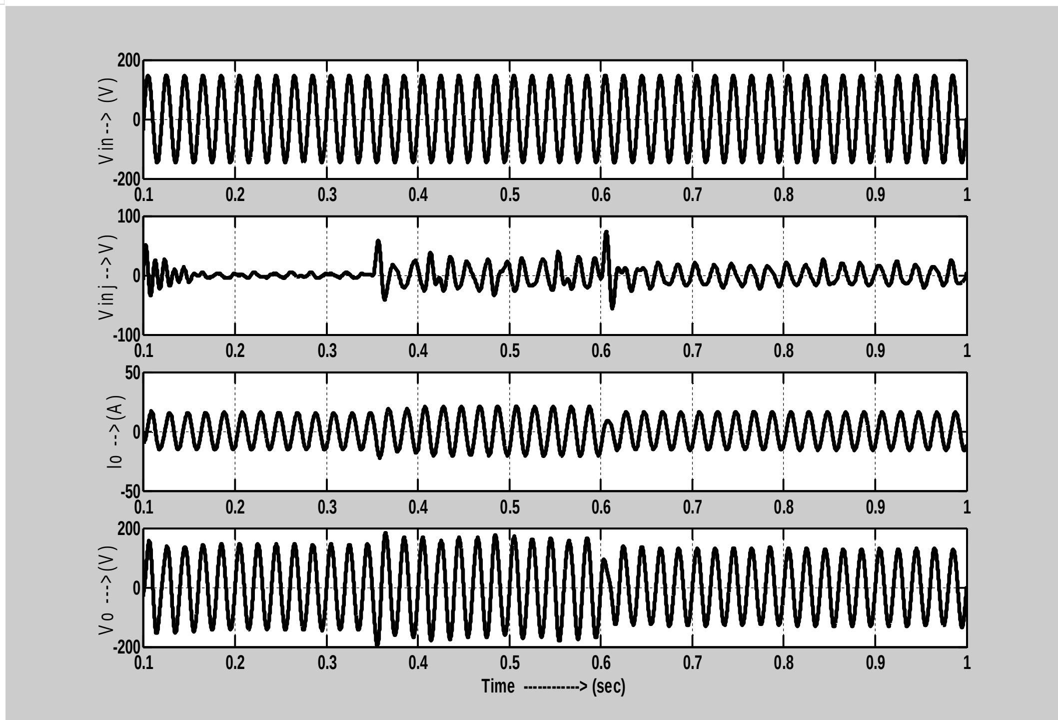


Fig.4: Wave forms of source voltage(V_{in}), injected voltage(V_{inj}), load current (I_o) and load voltage(V_o)

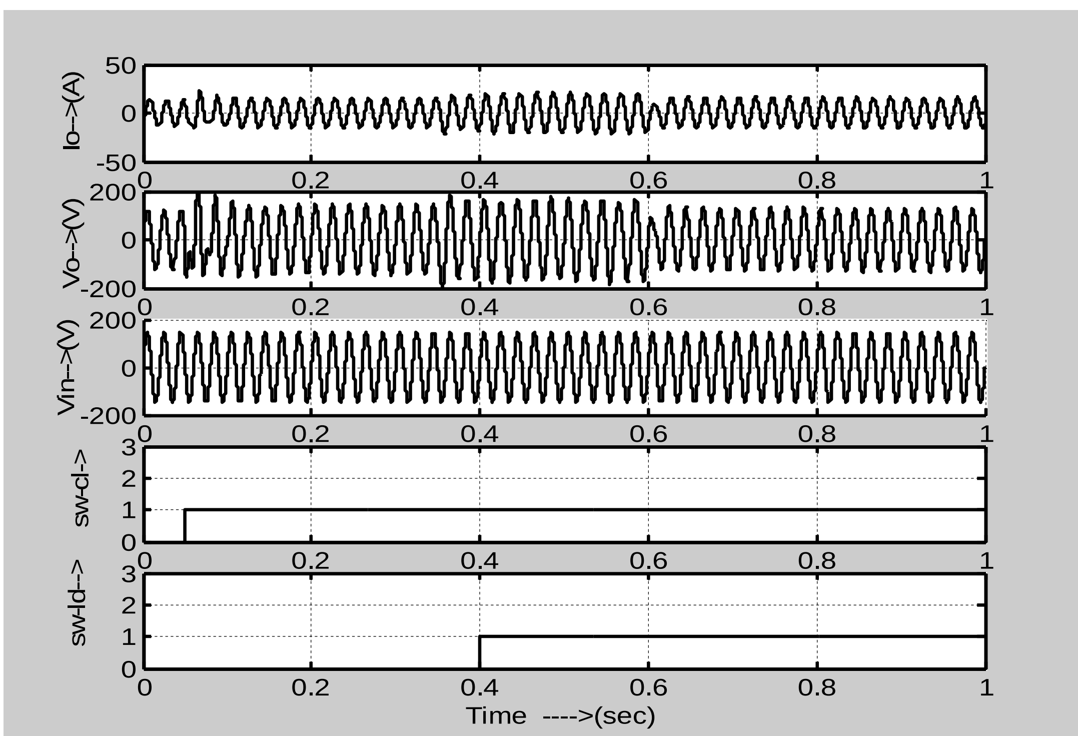


Fig.5: Waveforms og load current, load voltage, input voltage along with instant of application of control switch and load switch

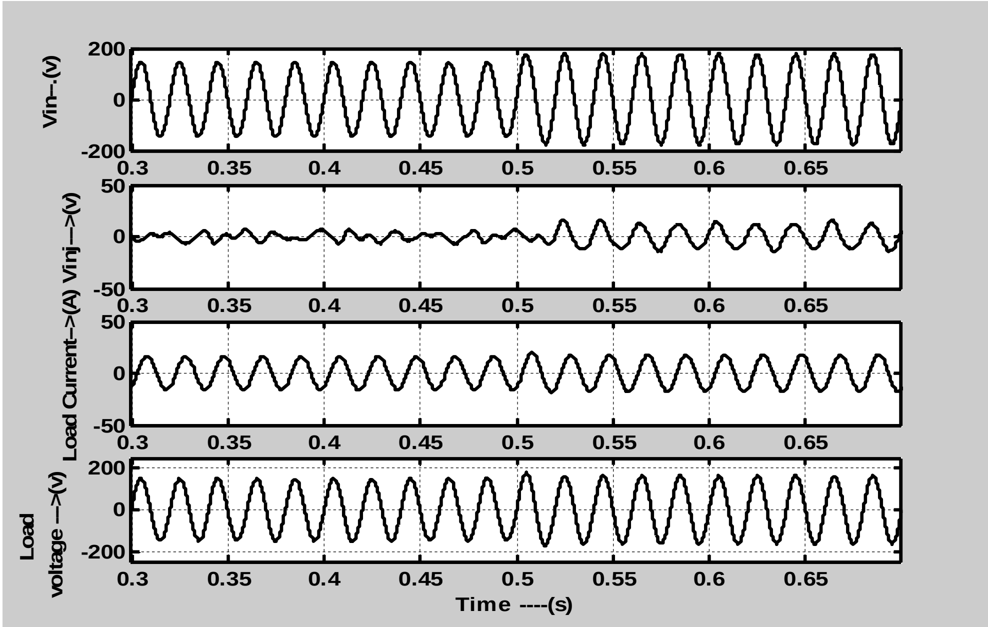


Fig.6: Wave forms of source voltage(V_{in}), injected voltage(V_{inj}), load current (I_o) and load voltage(V_o), when there is step=change in input and refence as constant

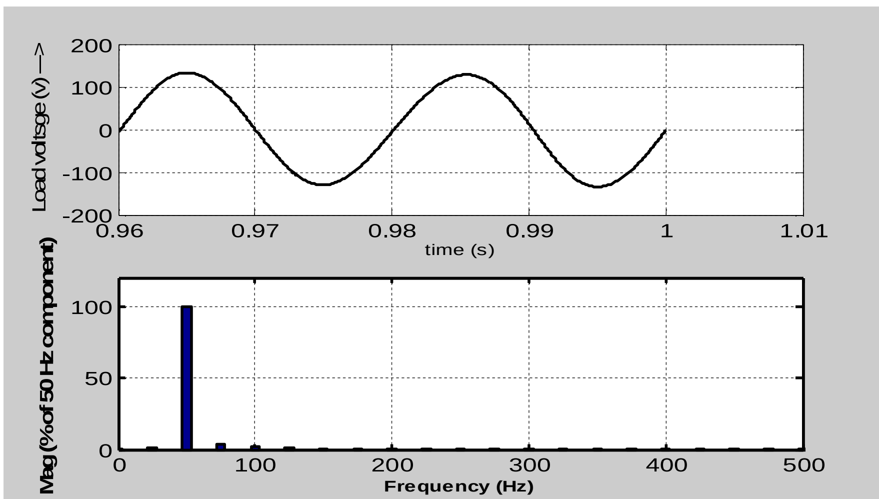


Fig.7: Harmonic analysis of load voltage upto 500 Hz

VI. CONCLUSION

In the field of power quality, the voltage dip problem has emerged a major concern. This problem is investigated using parameters of a prototype model. The effective algorithm has been developed in order to obtain a fast response of the device. The analysis a 1-phase SSRVR is carried out using MATLAB/Simulink The results of simulation are presented and discussed. The action of sliding mode controller in SSRVR demonstrates a highly effective, a flexible and robust operation for voltage regulation in power systems.

A. *Appendix*

Rated voltage= 150~200v/ph , Frequency = 50 Hz;

1-phase Series Transformer: Rated power= 3.3KVA, Primary/secondary parameters: R (0.0015 pu), L(0.005pu); Magnetization reactance = 1.85pu, Magnetization resistance = 10 pu;

PWM Based, Dc side voltage= 100 V, Frequency modulation ratio = 40;
Harmonic Filter: Primary side: (T-Filter): Lf =2mH, Rating of Cf= 3 kVAR;
Load: R=5 ohm, L = 25 mH; Auxiliary load: R=40 ohm. L = 1mH;

REFERENCES

[1] W.E. Kazibwe, R.J.Ringlee and G.W, Woodzell, “Power quality: A review,” IEEE Computer Application in Power, pp. 39-42, Jan 1990.

[2] G. Yalcinkaya, M.H.J. Bollen and P.A. Crossley, “ Characteristics of voltage sags in industrial distribution systems,” IEEE Trans on Industry Appl,, vol. 34, no. 4, pp. 682-688, July/Aug 1998.

[3] S.S.Choi, B.H.Li and D.M.Vilathgamuwa, “Dynamic voltage restoration with minimum energy injection,” IEEE Trans. Power Syst. , vol.15, no.1, pp. 51-57, Feb.2000.

[4] H.Ding and et.al., “A novel dynamic voltage restorer and its unbalanced control strategy based on space vector pwm,” Elect Power Energy Syst., vol-24, no.9, pp. 693-699, Nov-2002.

[5] D.M.Vilathgamuwa and et.al., “Voltage sag compensation with energy optimized dynamic voltage restorer,” IEEE Trans on Power Delivery, vol. 18, no. 3, pp. 928-936, July 2003.

[6] C.Fitzer, M.Barnes and P.Green, “Voltage sag detection technique for a dynamic voltage restorer,” IEEE Trans on Industrial Application, vol. 40, no. 1, pp. 203-212, Jan/Feb 2004.

[7] J.G.Nielsen, M.Newman, H.Nielsen and F.Blaabjerg, “Control and testing of a dynamic voltage restorer (DVR) at medium voltage level,” IEEE Trans on Power Electronics, vol. 19, no. 3, pp. 806-813, May 2004.

[8] H.Awad, J.Svensson and M.Bollen, “Mitigation of unbalanced voltage dips using static series compensator,” IEEE Trans on Power Electronics, vol. 19, no. 3, pp. 837-846, May 2004.

[9] M.J.Newman and et.al., “A dynamic voltage restorer with selective harmonic compensation at medium voltage level,” IEEE Trans on Industrial Application, vol. 41, no. 6, pp. 1744-1753, Nov/Dec-2005.

[10]B. Delfino, F.Fornari and R. Procopio, “An effective SSC control scheme for voltage sag compensation,” IEEE Trans on Power Delivery, vol. 20, no. 3, pp. 2100-2107, July 2005.

[11]I.Riberio and E.R.Barbi, “Harmonic voltage reduction using a series active filter under different load conditions,” IEEE Trans on Power Electronics, vol. 21, issue-25, pp. 1394-1402, Yr-2006.

[12]C.S.Lam, M.C.Wong and Y.D.Han, “Voltage swell and overvoltage compensation with undirectional power flow controlled dyanamic voltage restorer,” IEEE Trans on Power Delivery, vol. 23, no. 4, pp. 2513-2521, Oct-2008.

[13]S.K.Jain, P.Agrawala and H.O.Gupta, “Fuzzy logic controlled shunt active filter for power quality improvement,” IEE Procedding of EPS., vol. 149, no.7, pp. 317-328,2002.

[14] G.K.Singh, A.K. Singh and R.Maitra, “A simple fuzzy logic based robust active power filter for harmonics minimization under random load variation,” EPSR, Elsevier Publ, vol.77, 8, pp.1101-1111, Yr-2007.

[15]A. Luo, Z. Shuai, W. Zhu, R. Fan, and C. Tu, “Development of hybrid active power filter based on the adaptive fuzzy dividing frequency-control method,” IEEE Trans on Power Delivery, vol. 24, no. 1, pp. 424-432, Jan-2009.

[16]B.Panda,A.K.Mohapatra, D.P.Bagarty and S,Behera,”Fuzzy logic Controller-based dynamic voltage restorer for mitigation of voltage sag”, International Journal of Engineering Science and Technology, Vo.3, no.2, pp 996-1007, Yr-2011.

[17]S. Y. Hui, C. K. Lee, and F. F. Wu, “Electric springs - a new smart grid technology,” IEEE Transactions on Smart Grid, vol. 3, no. 3, pp. 1552–1561, Sept 2012.

[18]C. K. Lee, N. R. Chaudhuri, B. Chaudhuri, and S. Y. R. Hui, “Droop control of distributed electric springs for stabilizing future power grid,” IEEE Transactions on Smart Grid, vol. 4, no. 3, pp. 1558–1566, Sept 2013.

[19]C. K. Lee and S. Y. . Hui, “Reduction of energy storage requirements in future smart grid using electric springs,” IEEE Transactions on Smart Grid, vol. 4, no. 3, pp. 1282–1288, Sept 2013.

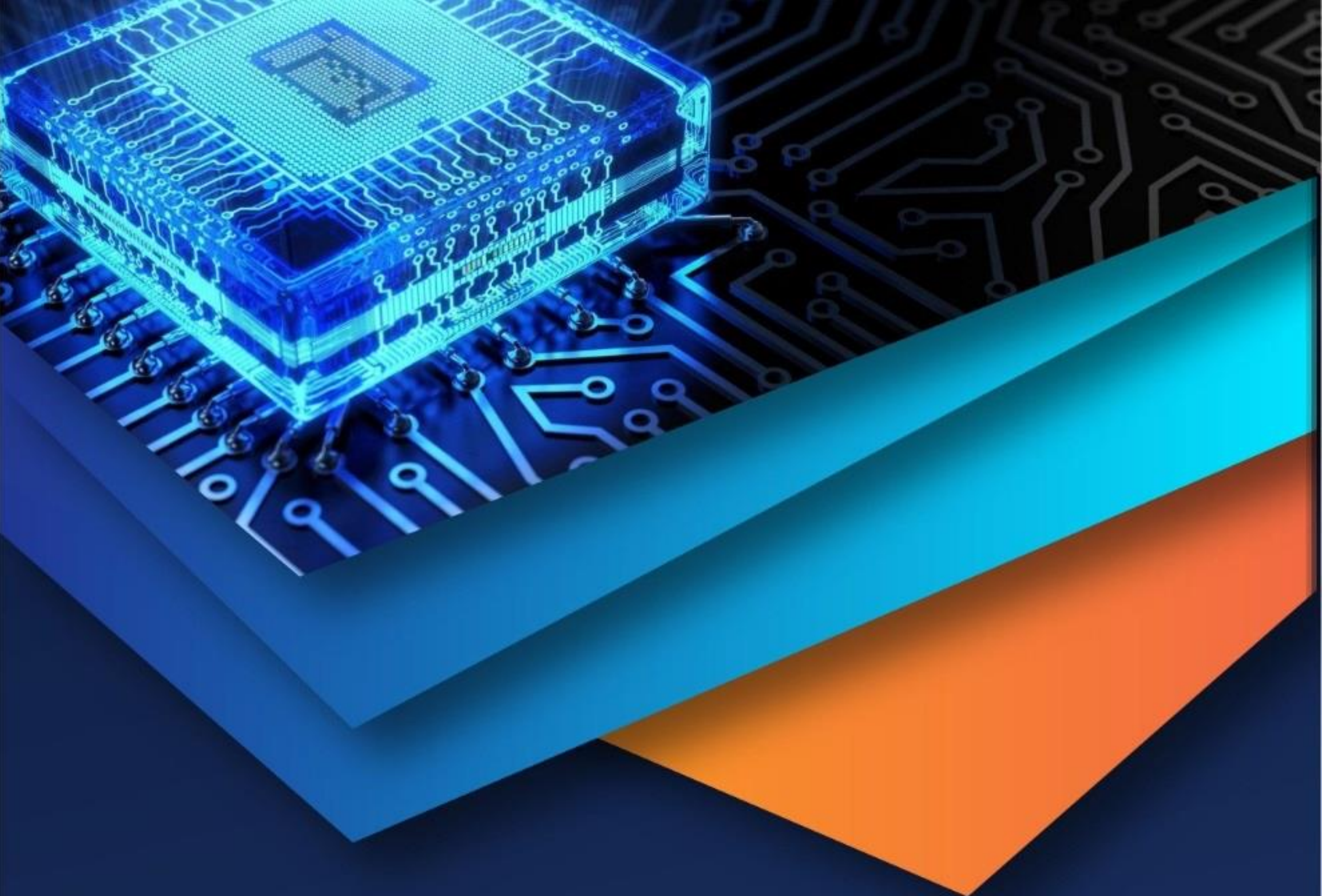
[20]N. R. Chaudhuri, C. K. Lee, B. Chaudhuri, and S. Y. R. Hui, “Dynamic modeling of electric springs,” IEEE Transactions on Smart Grid, vol. 5, no. 5, pp. 2450–2458, Sept 2014.

[21]J. Soni and S. K. Panda, “Electric spring for voltage and power stability and power factor correction,” in 2015 9th International Conference on Power Electronics and ECCE Asia (ICPE-ECCE Asia), June 2015, pp. 2091–2097.

[22]Q. Wang, M. Cheng, and Z. Chen, “Steady-state analysis of electric springs with a novel delta control,” IEEE Transactions on Power Electronics, vol. 30, no. 12, pp. 7159–7169, Dec 2015.

[23]K. T. Mok, S. C. Tan, and S. Y. R. Hui, “Decoupled power angle and voltage control of electric springs,” IEEE Transactions on Power Electronics, vol. 31, no. 2, pp. 1216–1229, Feb 2016.

[24]M. Carpita, et al., “Power conditioning system using sliding mode control,” IEEE Trans on Power Electronics Specialists Conf. Rec.,1988, pp. 626-633.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY