International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 2 Issue 8, August-2013, pp: (38-42), Available online at: www.erpublications.com

Smoothening of voltage profile for small transmission line by using Fixed Capacitor-Thyristor Controlled Reactor (FC-TCR)

Ghanshyam Vishwakarma[1], Mr. Nitin Saxena[2]
[1]M.E. scholar, [2]Assistant Professor
Jabalpur Engineering College, Jabalpur, M.P., India

Abstract: This paper addresses improving the voltage stability limit of power flow between two different regions in an electric power system using the Fixed capacitor Thyristor controlled reactor (FC-TCR) or Static Var Compensator (SVC). Modelling and simulation of Static Var Compensator (SVC) for power system stability enhancement and improvement of power transfer capability have been presented in this paper. First, power flow results are obtained and then power (real and reactive power) profiles have been studied for an uncompensated system and then compared with the results obtained after compensating the system using the above-mentioned SVC device. The simulation results demonstrate the performance of the system in improving the power profile and thereby voltage stability of the same. All simulations have been carried out in MATLAB/SIMULINK environment. A methodology for determining the power flow margin is simply briefed.

Keywords: SVC, power quality, MATLAB/SIMULINK, FC_TCR.

1. Introduction

Increased use of transmission facilities owing to higher industrial demand and deregulation of the power supply industry has provided the necessity for exploring new ways of maximizing the power transfers of existing transmission facilities, while maintaining acceptable levels of system reliability and stability [1]. In such an environment, application of the Flexible AC Transmission System (known as FACTS) in power systems has become an issue of great concern. The FACTS facilitates power flow control, increased power transfer capability, and enhances the security and stability of power systems without expanding transmission and generation utilities.

Excellent applications of FACTS controllers, such as the unified power flow controller (UPFC), and the Static Synchronous Compensator (STATCOM), have yielded successful results [2]. It has been shown in recent case studies that FACTS can provide a more flexible stability margin to power systems and also improve power transfer limit in either shunt or series compensation [3, 4].

This paper focuses on studying the effect of SVCs on the voltage stability limit of interface flow. Interface flow limit is defined as the maximum power transfer that can be allowed through interface lines connecting two regions of a power system in terms of the steady-state voltage stability.

A power flow model of a SVC is proposed to make a practical study of the influence of SVCs on the interface flow limit. The SVC, a gate turn-off (GTO) thyristor based shunt voltage source inverter (VSI), injects the shunt-compensating voltage almost in quadrature with the line current, controlling the line impedance and active power flow. The SVC power flow model is obtained by adding such control characteristics to the VSI injection model. This model of SVC compensated system is described in the next points with the simulation model and its results were described.

2. Theoretical description

The survey reported in [7] shows that 68% of the power disturbances were voltage sags, and these types of disturbances were the only cause of production losses. Static VAR compensated FACTS device are the most important device and have been used for a number of years to improve voltage and power flow through the transmission line by resolving dynamic voltage problems. SVC is shunt connected static generator/absorber. Utilities of SVC controller in transmission line are many:

a) Provides high performance in steady-state and transient voltage stability control.
b) Dampen power swing.
c) Reduce system loss.
d) Control real and reactive power flow.

Simple FC-TCR type SVC configuration is shown in figure 1. In FC-TCR, a capacitor is placed in parallel with a thyristor controlled reactor. I_s, I_r and I_c are system current, reactor current and capacitor current respectively which flows through the FC-TCR circuit. Fixed capacitor- Thyristor controlled reactor (FC-TCR) can provide continuous lagging and leading VARS to the system [5]. Circulating current through the reactor (I_r) is controlled by controlling the firing angle of back-back thyristor valves connected in series with the reactor. Leading var to the system is supplied by the capacitor. For supplying lagging vars to the system, TCR is generally rated larger than the capacitor.

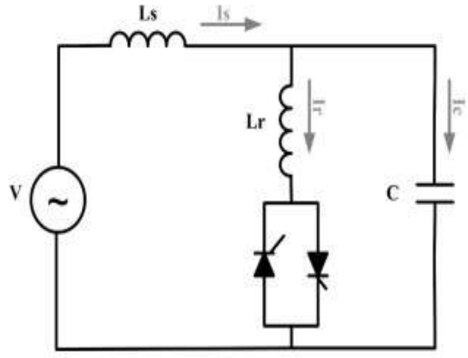

Fig 1: SVC system

3. Modelling of the devices

The modelling of SVC compensated system is described as given below. The system is modelled by using MATLAB/SIMULINK. And their results are obtained by simulation of the system.

3.1 Single phase Uncompensated system

Figure 2 shows the basic transmission (11kV, 50Hz) model of an uncompensated system. This model consists of different buses at which the simulation results were obtained by scopes. 11kv voltage is supplied from the AC voltage source to the system. Source resistance and inductances are 0.01Ω and 0.01H and load is kept constant at 30KW and 10KVAR for the above transmission line model. Simulation is done using MATLAB/SIMULINK. We got results of the simulation as shown in figure 4 given below:

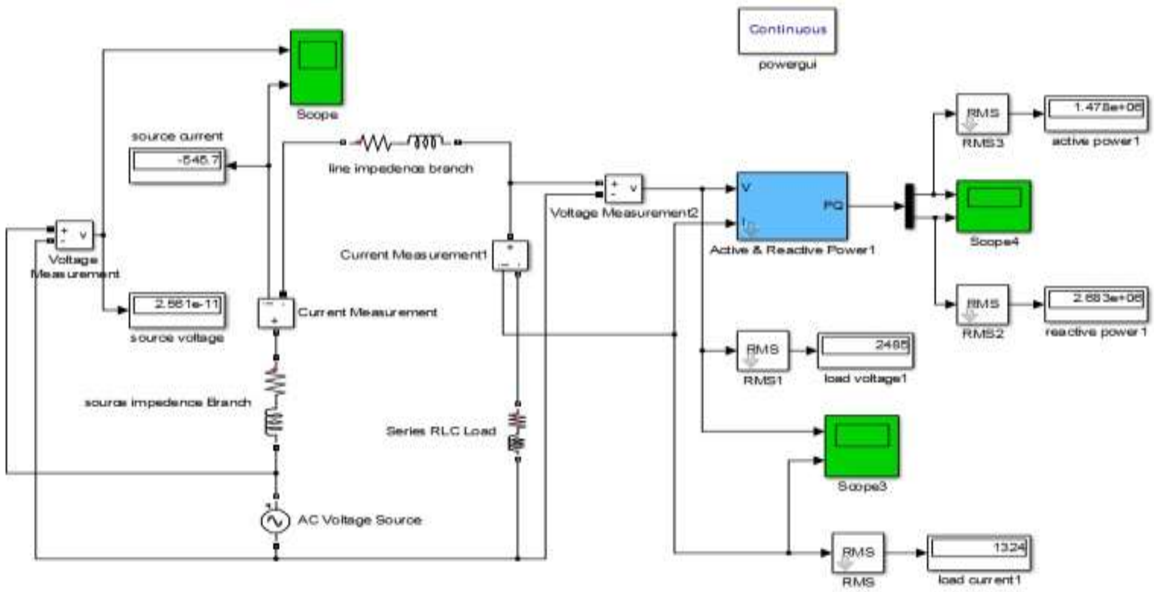

Fig 2: Uncompensated system

3.2 SVC Compensated model

The compensated system model is shown in the given figure 3 below which consists of a single phase voltage source transmission line a SVC. This model is simulated by using MATLAB and we got the simulation results as shown below in figure 5.

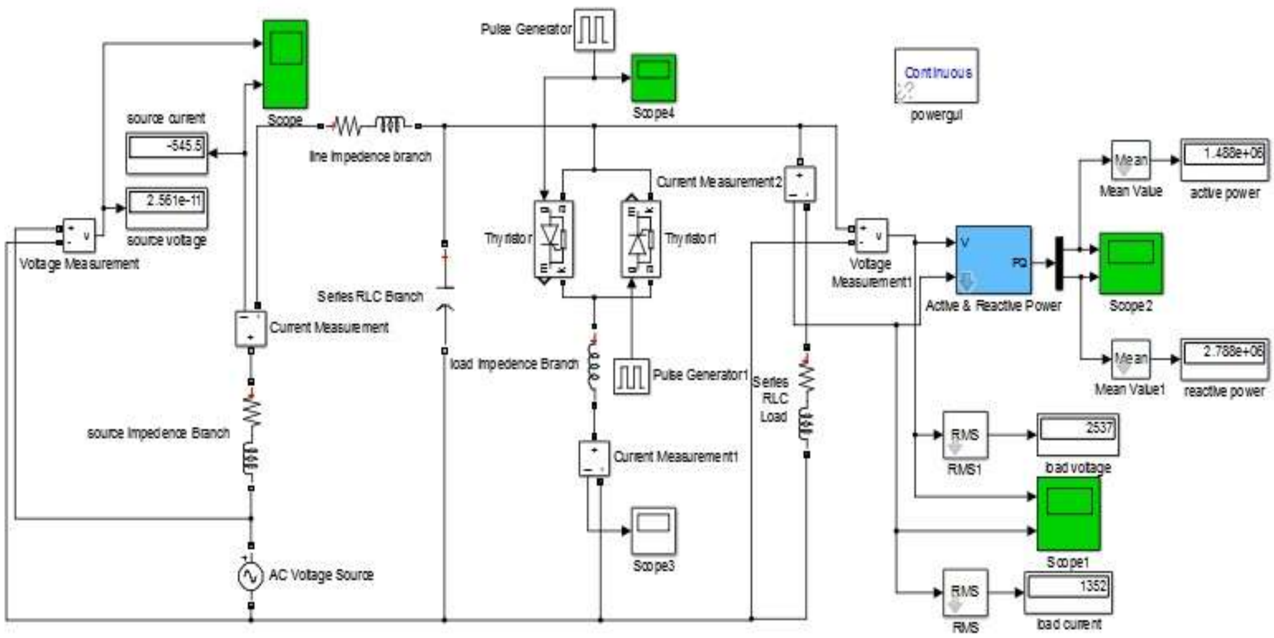

Fig 3: SVC Compensated system

4. Results and discussion

As the simulation is done using MATLAB/SIMULINK, we get some waveform these waveform shows active power, reactive power, load voltage and load current respectively for the single phase compensated and uncompensated systems. The results of all those compensated and uncompensated systems are shown in the given figures below.

4.1 For uncompensated system

The figure given below shows the results of the uncompensated system in which figure 4.1 shows the active power and reactive power respectively. It shows that active power is 1.433MW and reactive power is 2.681Mvar. By using SVC compensation we have to enhance the value of these active and reactive powers.

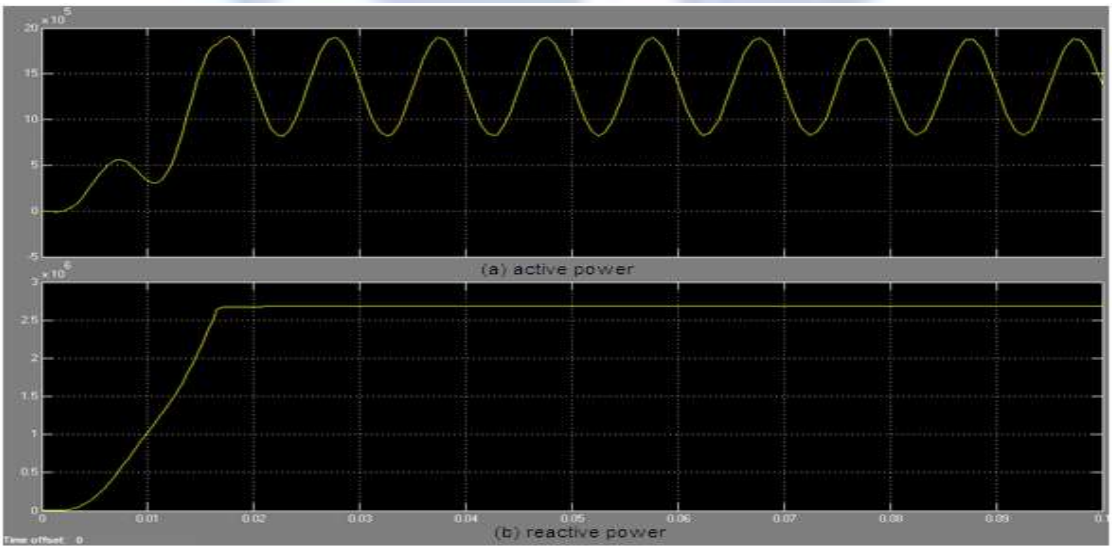

Fig 4.1: Active and reactive power's respectively of an uncompensated system

The figure given below shows the results of the uncompensated system in which figure 4.2 shows the load voltage and load current respectively. It shows that the load voltage is 2.4kv and load current is 1.3kamp. By using SVC compensation we have to enhance the value of these load voltage and load current also.

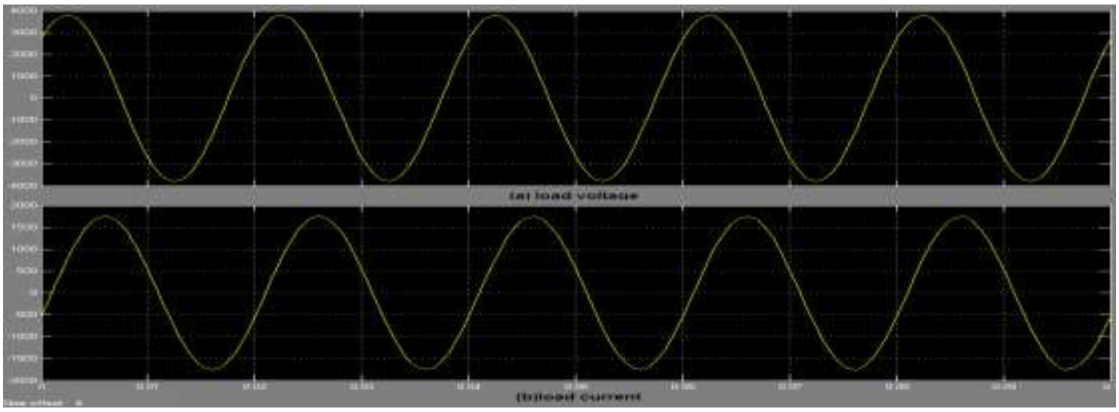

Figure 4.2 Load voltage and current's respectively of an uncompensated system

Table 4.1 different values obtained for uncompensated system

Active power (MW)	Reactive power (MVAR)	Voltage (V)	Current (A)
1.433	2.681	2483	1324

4.2 For compensated system

The given below figure 4.3 shows the waveform for active and reactive powers respectively and figure 4.4 shows the waveforms of the load voltage and load current. The system is simulated for different values of capacitance that is we change the values of capacitance from 50µF to 1500µF and the different results were tabulated in the table 4.2

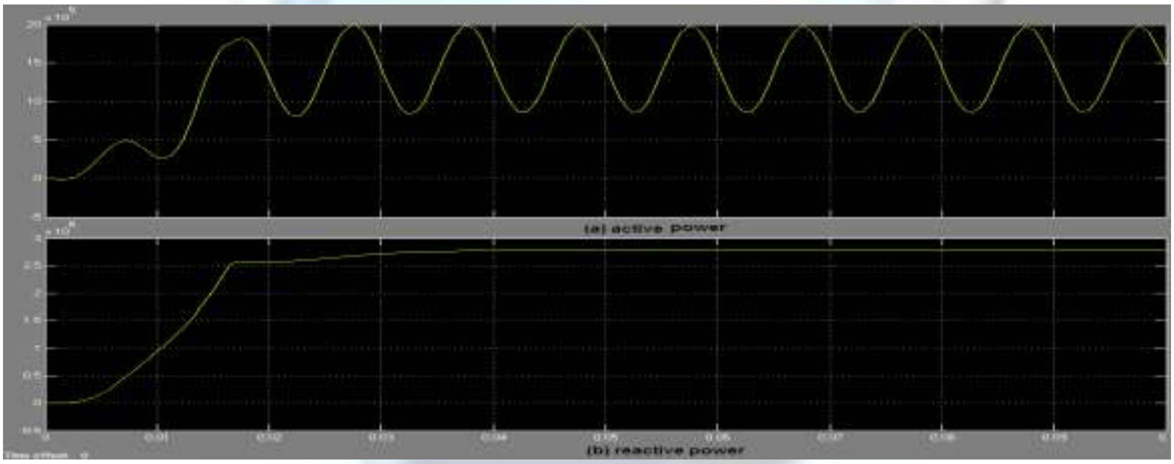

Figure 4.3 Active and reactive power's respectively of ancompensated system

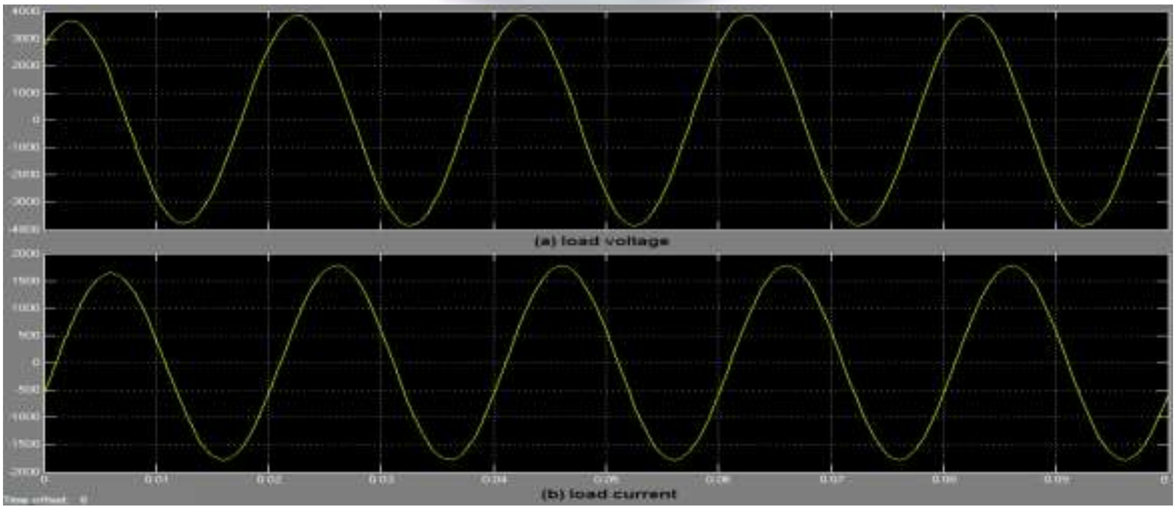

Figure 4.4 Load voltage and current's respectively of an compensated system

Table 4.2 variation of power flow with change of capacitance

S. No.	Capacitance (µF)	Real power(MW)	Reactive power (MVAR)	Load voltage(V)	Load current(A)
1	50	1.488	2.788	2537	1352
2	200	1.665	3.129	2704	1437
3	350	1.853	3.506	2888	1525
4	500	2.048	3.910	3084	1609
5	600	2.180	4.184	3217	1664
6	800	2.420	4.718	3487	1758
7	1000	2.602	5.162	3735	1820
8	1200	2.683	5.426	3917	1835
9	1400	2.645	5.444	4004	1799
10	1500	2.582	5.356	4007	1763

5. Conclusion

From the above simulation we conclude that SVC is able to compensate and increase all the parameters of the system. So as increases the power transmission capability of the system. As we have seen that the power transfer capability is still less so we have to improve our system performance by changing the values of capacitance, so we had varied the values of the capacitance from 50µF to 1500µF.

The simulation results indicated a considerable increase in power flow limit by SVC compensation. Further study on impacts of various FACTS controllers such as UPFC, STATCOM, etc. should be carried out to seek for the most effective way of increasing the power flow limit.

References

[1]. CIGRE, “FACTS Overview”, IEEE Power Engineering Society, 95 TP 108, April 1995.
[2]. N. G Hingorani& Laszlo Gyugyi, “Understanding FACTS: concepts and technology of flexible AC transmission System”, IEEE Press, New York(2000).
[3]. K. R. Padiyar, “FACTS controllers in power transmission and distribution,”New Age Int. Publisher, 2007.
[4]. Abhijit Chakrabarti & Sunita Halder, “Power System Analysis Operation and Control”. Prentice Hall of India Pvt. Limited, New Delhi, 2006.
[5]. Anulekha Saha, Priyanath Das and Ajoy Kumar chakraborty, “Performance Analysis and Comparison of Various FACTS Devices in Power System”, International Journal of Computer Applications, Volume 46-No.15,May2012.
[6]. M. P. Donsion, J. A. Guemes, J. M. Rodriguez, “Power Quality Benefits of Utilizing FACTS Devices in Electrical power System”, IEEE 2007, 26-29.
[7]. V. E. Wagner, A. A. Andreshak, and J. P. Staniak, “Power quality and factory automation,” IEEE Transactions on Industry Applications, vol. 26, no. 4, pp. 620– 626, July/Aug. 1990.
[8]. Dr.B.R.Gupta & Er.Vandana Singhal, “Power System Operation and Control”, S. Chand Publications.