International Journal of Electrical and Electronics Engineers
Vol. No.8 Issue 01, January-June 2016
www.arresearchpublication.com
IJEEE
ISSN 2321 - 2055

INTRODUCTION TO FC–TBSR BASED SVC FOR VOLTAGE REGULATION AND REACTIVE POWER COMPENSATION

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ABSTRACT

In this paper, fixed capacitor thyristor binary switched reactor based SVC is proposed for transmission system. It consist thyristor switched reactor (TSR) banks in binary sequential steps known as thyristor binary switched reactor (TBSR) with fixed capacitor. The conventional SVC, TCR plays important role but TCR inject the harmonics in the system, which is not acceptable in many acceptable in many situations. To eliminate the harmonics thyristor switched reactor (TSR) in binary switching pattern are used. This system is implemented for the single phase with static load condition the result shows significant development in voltage regulation at load bus and reactive power compensation.

***Keywords:* FC-TBSR, SVC, Reactive Power Compensation, Transmission system, Voltage Regulation**

I. INTRODUCTION

Power transmission and distribution lines are the vital links that achieve the essential continuity of service of electrical power to the end users. Transmission lines connect the generating stations and load centers. As the generating stations are far away from the load centers they run over hundreds of kilometers. Hence, the chances of fault occurring in transmission lines are very high. Since faults can destabilize the power system they must be isolated immediately. Voltage control in an electrical power system is important for proper operation of electrical power equipment to prevent damage such as overheating of generators and motors, to reduce transmission losses and to maintain the ability of the system to withstand and prevent voltage collapse. Transmission systems the voltage needs to be continuously monitored and controlled to compensate for the Daily changes in load, generation and network structure [1, 2]. In fact, the control of voltage is a major issue in power system operation.TSR is most suitable economical solution for constant loads and grid conditions in some applications there is a need to consume the inductive reactive power insteps. In order to overcome these limitations and to ensure precise control, the reactor bank is arranged in binary sequential steps to enable reactive power variation with least possible resolution and all most stepless way. However, variable reactors are the best solution for accommodating wide load fluctuations on the line and changing grid conditions in future (for example due to grid expansion or changes in the power generation structure) [3].

II. PRINCIPLE OF FC-TBSR

2.1 FC-TBSR based SVC

FC-TBSR consists of an anti-parallel connected thyristor as a bidirectional switch in parallel with a reactor and fixed capacitor. Transient free switching of reactor is obtained by satisfying following two conditions [4].

a. Firing the thyristors at the negative/positive peak of supply voltage.
b. At the zero crossing of the line current

At the load bus line requiring total reactive power Q for improving the from some initial value. TBSR based SVC located at the load bus provides reactive power and voltage regulation for load. This Q can be arranged in binary sequential 'n' steps, satisfying the following equation [5, 6].

$$Q = 2^n L + 2^{n-1} L + \ldots\ldots\ldots + 2^2 L + 2^1 L + 2^0 L$$

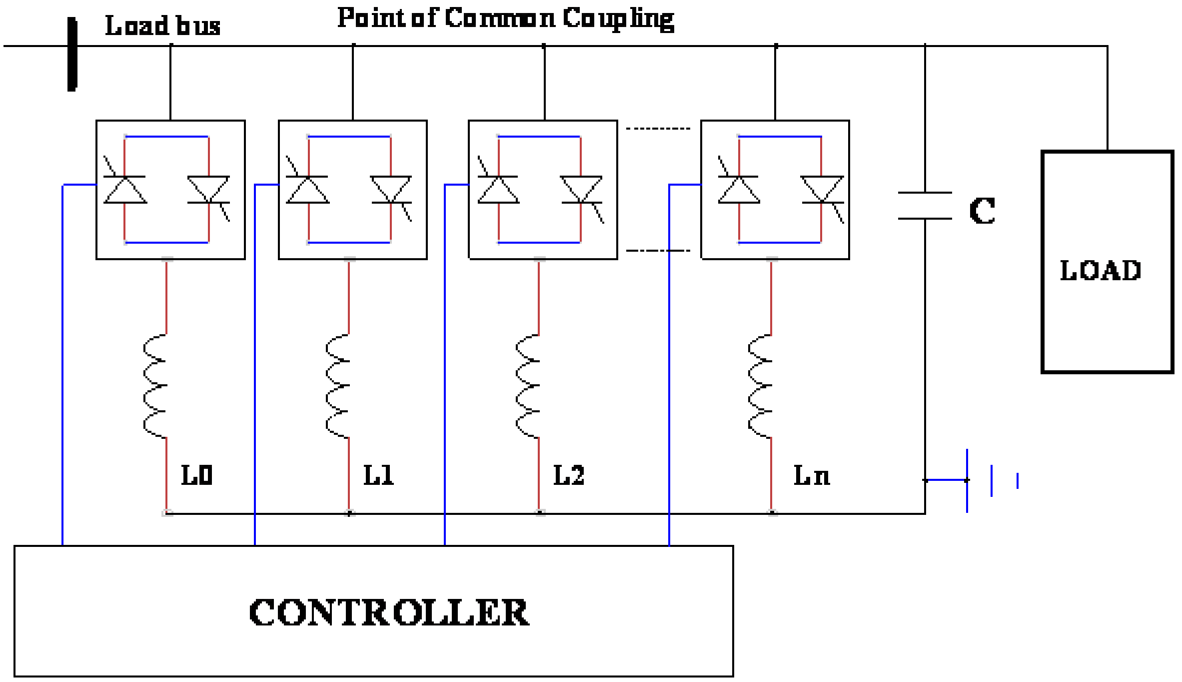

Fig. 1: FC-TBSR SVC for load bus

In the proposed scheme, reactor bank step values are chosen in binary sequence weights to make the resolution small. If such 'n' reactor steps are used then 2^n different compensation levels can be provided. In this scheme four TBSR banks are arranged as 10, 20, 40 mH connected with fixed capacitor the objective in the switching strategy is to be developed through the simulation, to make the switching operation transient free and binary voltage generation for all combinations. The sequence employed for switching operation is as follows [7, 8]:

Step - 1 : Reactor L_1 is brought ON for one cycle and OFF for one cycle.
Step – 2 : Reactor L_2 is brought in when step 1 is OFF and kept ON for two cycles.

Step – 3 : Reactor L_3 is switched ON after 1 and 2 are kept ON for four cycles.

2.2 Control Strategy

The objective here is to maintain power factor close to unity always, for all load levels during the day. For this purpose the reactor bank in three binary sequential steps where operated, it is possible to get almost stepless variation of reactive power in the range of 0 VAR to 700 VAR shown in Fig.1. The current and voltages are sensed and fed to a dedicated microcontroller to perform necessary calculations and arrive at the number of steps operation. This will enable close matching of the compensator reactive power output with the prevailing load.

2.3 Control Strategy for Switching of TBSR Bank

In this paper we are chosen reactor bank in binary sequence and also its switching operation is in the form of binary sequence. In fig.1 shows the switch strategy for TBSR bank.

Table 1: Switching Strategy

Sr. No.	L_3 (400 Var)	L_2 (200 Var)	L_1 (100 Var)	Load Demand (Q) in Var
1.	OFF	OFF	ON	100
2.	OFF	ON	OFF	200
3.	OFF	ON	ON	300
4.	ON	OFF	OFF	400
5.	ON	OFF	ON	500
6.	ON	ON	OFF	600
7.	ON	ON	ON	700

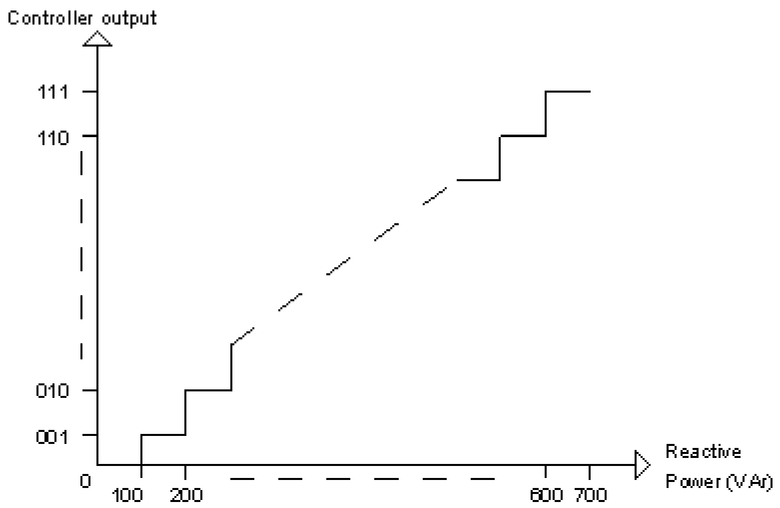

Fig. 2: Almost Stepless Control of Reactive Power

The total Q value for compensation chosen is 700VAR, arranged in the following three binary sequential steps with values and corresponding signals that are given from controller to the respective thyristor are as above Fig.2.

Step-1-Q_0 = 100 VAR - S0 to Thyristor '0'
Step-2-Q_1 = 200 VAR - S1 to Thyristor '1'
Step-3-Q_2 = 400 VAR - S2 to Thyristor '2'

The controller receives both current and voltage signals through CT and PT, performs necessary calculations through an in built program and generates the activating signals S0, S1, and S2, so as to match the reactive power from the compensator with the prevailing load demand.

III.TRANSMISSION LINE MODEL

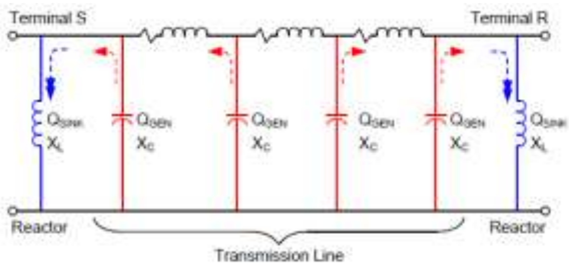

Fig. 3: Transmission Line Model

For **π** type transmission lines, the parasitic capacitance of the line becomes significant enough that it impacts the sending end and receiving-end voltages and current. The result of this is that under light-load conditions, the line produces more VARs than it consumes therefore, there is an excess of VARs on the line, resulting in the receiving-end voltage being higher than the sending-end voltage. In order to consume the excess VARs when the system is lightly loaded, a device that absorbs VARs must be added to the system. This addition should be done in the vicinity of the line to minimize the losses caused by the reactive current. Because we know that inductors absorb VARs, a reactor is connected in parallel with the shunt capacitance of the line. Therefore, the VARs produced by the shunt capacitance of the line (QGEN) are consumed by the shunt reactors connected in parallel with the line (QSINK).

IV. DESIGN AND IMPLEMENTATION

4.1 Voltage Regulation for Static Load and dynamic load

In this paper, a transmission line is used to show the performance of the FC-TBSR Based SVC device on voltage regulation with static and dynamic load. Due to the Ferranti effect voltage at receiving end increases hence problem of voltage regulation and reactive power compensation rises. Proposed schme provides exact required reactive power by using the binary switched reactor arrangement. If the line having problem of voltage sag fixed capacitor provides necessary reactive power. FC- TBSR Based SVC does not injects harmonics into to system It does not needed harmonics filter, is great Advantage of the system.

V. ADVANTAGES OF FC-TBSR

1. It maintains the voltage profile at load side to specified value.
2. Reactors are sized in binary sequential ratio for minimum size of switching steps.
3. It compensates for rapid variation in reactive power or voltages.
4. Step less control of reactive power is obtained to achieve very fast response
5. It eliminates possible over compensation and resulting leading power factor.
6. It is also used for mitigation of Ferranti effect.
7. It does not inject the harmonics into the system so it does not require filter.

VI. CONCLUSION

Recently voltage stability and power quality issues are important in the power system. Solution of the problem is to compensate reactive power. Here reactive power compensate by using FC-TBSR based SVC. The TSR bank step values are chosen in binary sequence weights to make the resolution small. Current flowing through TBSR as well as source is transient free. In this paper effect of FC-TBSR SVC on the load voltage has presented. The modeling and simulation has verified on MATLAB. The simulation result demonstrated that installation of TSR-Based SVC in the system is caused to improve power factor and voltage profile for both static loads.

REFERENCES

[1] Gelen, Tankut Yalcinoz "Experimental studies of a scaled-down TSR-based SVC and TCR-based SVC prototype for voltage regulation and compensation" *Turk J Elect Eng. & Comp. Sic, Vol.18, No.2, 2010, T¨UB˙ITAK doi: 10.3906/elk-0907-138.*

[2] Gelen, T. Yalcinoz. "Analysis of TSR-based SVC for a three-phase system with static and dynamic loads. *In Proc. of the IEEE Int. Conf. on Electrical Engineering (ICEE), Lahore, Pakistan, pp. 1-6, April 11-12, 2007.*

[3] Gelen, T. Yalcinoz, "Modeling and Simulation of TSR based SVC on Voltage Regulation for Three-Bus System", *3rd International Symposium and Exhibition on Electrical, Electronic and Computer Engineering, (ISEECE-2006), Near East University, Nicosia, TRNC, pp. 167-171, 23-25 Nov. 2006.*

[4] D. R. Patil Member IAENG, Irfan Isak Mujawar, Isak Ismail Mujawar, Swapnil.D.Patil "TBSC-TCR Compensator Simulation A New Approach in Closed Loop Reactive Power Compensation of Dynamic Loads" *Proceedings of the International Multi Conference of Engineers and Computer Scientists 2014 Vol II, IMECS 2014, March 12 - 14, 2014,Hong Kong.*

[5] Swapnil Patil, Yogesh Shinde, Khushal Shende U. Gudaru, Senior Member IEEE, D.R. Patil Member, IAENG, "Transient Free TBSC Compensator for Dynamic Reactive Load with Closed Loop Control", *Proceedings of the WCECS 2013 Vol I WCECS 2013.23-25 October, 2013, San Francisco, USA.*

[6] Swapnil D. Patil, Anwar M. Mulla, U. Gudaru, D. R. Patil, *Member IAENG, "*An Innovative Transient Free TBSC Compensator with Closed Loop Control for Fast Varying Dynamic Load" Proceedings of the World Congress on Engineering and Computer Science 2014 Vol I WCECS 2014, 22-24 October, 2014, San Francisco, USA.

[7] Swapnil D. Patil, Irfan I. Mujawar, U. Gudaru, *Senior Member IEEE*, D. R. Patil *Member,IAENG, "*A Closed Loop TBSC Compensator for Direct Online Starting of Induction Motors With Voltage Sag Mitigation*" Proceedings of the World Congress on Engineering and Computer Science 2013 Vol I WCECS 2013, 23-25 October, 2013, San Francisco, USA*.

[8] Swapnil. D. Patil, Irfan Mujawar, Isak Mujawar, D. R. Patil, *Member, IAENG*, U. Gudaru, *Senior Member IEEE*, "TBSC-TCR Compensator Simulation: A New Approach in Closed Loop Reactive Power Compensation of Dynamic Loads", *Proceedings IMECS 2014, Vol II, March 12 - 14, 2014, Hong Kong.*.