



Scientia Research Library

Journal of Engineering And Technology Research
, 2013, 1 (1):94-99

<http://www.scientiaresearchlibrary.com/archive.php>

Voltage stability Enhancement and power oscillation damping using static synchronous series compensator with SMES

A. A. Malgave¹ , M.B. Shelar² and A.M. Mulla^{*}

*Power System Annasaheb Dange College of engineering and technology Ashta, Sangli,
416301 Maharashtra, India¹.*

Power system Ashokrao Mane Group of institutions Vathar 416112, Kolhapur, Maharashtra, India²

ABSTRACT

By using FACTS devices we maintain the stability of the power system .As we are using the shunt and series compensator to maintain the power system stability and to damp the power oscillation. The main purpose of this paper is to maintain the stability by SSSC(Static synchronous series compensator) with SMES (Super conducting magnetic energy storage device) ,and the results are compared with and without SMES in MATLAB/Simulink.

Key words: SSSC(Static synchronous series compensator), SMES(Super conducting magnetic energy storage device).

INTRODUCTION

Today it is very difficult task to maintain the stability and to damp the power oscillation of the power system, as the power system is very complex in nature. So the use of FACTS device comes in the picture to maintain the stability we are using the FACTS devices. If the SMES (Super conducting magnetic energy stores device) is connected with FACTS devices the performance of the devices increases. To control the active and reactive power flow from the transmission line the power electronics devices are used this is proposed in the [1]-[2]. Now a days the FACTS devices used to control the magnitude of the current flowing through power system and that in a very low cost[3]. But the FACTS devices connected with the SMES having quite low information regarding the performance. so that this paper give the performance result when the FACTS devices connected with a energy storage device. Molina, M.G. discussed that, SSSC is most useful tool in case of the power system[4]. The SSSC having the better performance as some amount of the energy is stored in the SSSC and the brief discussion of the SMES is presented by Molina, M.G. et al. [5][6]. This paper gives the clear idea of SSSC with and without SSSC. The SMES is connected to the SSSC through the control circuit and the results are discussed with and without SMES.

MATERIALS AND METHODS

The SSSC with SMES

Fig.1 shows Voltage sourced converter is base for the SSSC. And this type of the series compensator the voltage across the line impedance that should be increased so that we will get the increase in current and finally the power. For the normal capacitive compensation the output current leads the voltage by 90° . But in this type of compensation the voltage and can make lag and lead by 90° by simple control action. If the energy storage device is connected then that is very helpful for transmitting the real power. Without energy storage device the transmission of the real power is not so efficient.

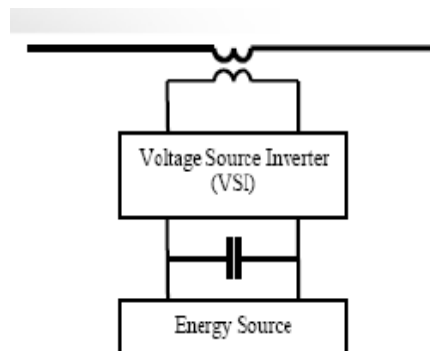


Fig.1 Basic configuration of SSSC with Energy source

The SSSC control methodology

The SSSC with two voltage source converters with the series transformers. The converters are connected in series with transmission line through the two winding transformers. The switching of the SSSC is synchronized with transmission line current I_{line} . The value of the I_{line} can be controlled by the phase shift α I_{line} current and the output voltage of the SSSC denoted by V_{pq} .

The change in the phase shift between output voltage of SSSC and the line current results in change in the output voltage of the SSSC (V_{SSSC}) [7]. Then the magnitude of the line current changes. The output voltage (V_{SSSC}) can be controlled by the simple closed loop circuit. From Fig.2

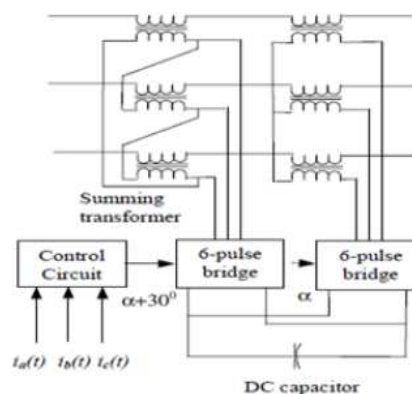


Fig 2 Transformer configurations of 12-Pulse SSSC.

Simply we have to compare the value of the measured line current and the actual line current values in per unit. The error is then passed through the PI controller, the output of the PI controller is the angle α [8]. Depending upon the angle α , an angle $-\pi/2$ to $+\pi/2$ has to be added in the since the SSSC output is lagging or leading the line current by 90° Depending upon the desired inductive and the capacitive operation. Depending on the output of the SSSC the real power is taken from the line or injected in line there by changing the value of the DC capacitor. Fig.3 illustrates the details of control circuit for the SSSC.

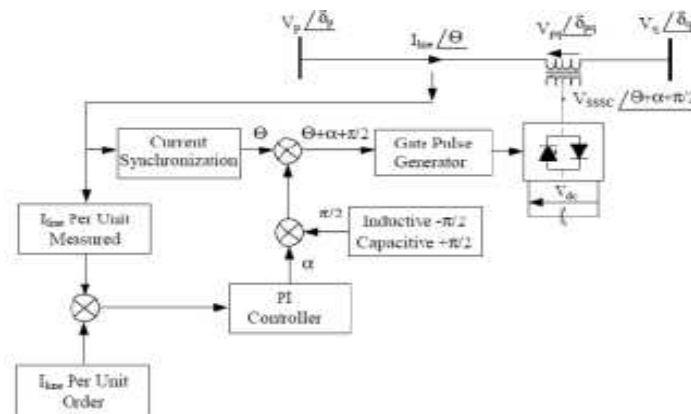


Fig.3 Functional control diagram for phase controlled SSSC

Chopper control for the SMES

SMES is the energy storage device which is highly efficient which has not moving part. The energy burst taking place due to this SMES so that is very beneficial as per as the power quality consideration. The chopper is needed when VSI and energy storage device are connected. Two quadrant 3 phase DC to DC converter is as shown in fig.4 [9]. The DC-DC chopper reduce the power rating capacity of the super conducting coil to the SSSC. The chopper consists of the diode or the thyristors that permit the high current. The storage, charging, and discharging are the three modes of operation of the chopper. The storage is present in the SMES device. The thyristors 'b' kept on all the time while 'a' is operated on the. Once the superconducting coil is charged then DC-DC converter changed to the standby mode for that set of thyristors "a" are kept off all the time while the set of thyristors "b" are kept on constantly. In discharge mode The set of thyristors "b" is operated with duty cycle D while the set of thyristors "a" is kept off at all times. so the DC bus voltage equation is given by the

$$V_{SMES} = D * V_{dc} \dots \dots \dots 1)$$

$$V_{SMES} = (1-D) * V_{dc} \dots \dots \dots 2)$$

The duty cycle ranges from 0 to 1.

$$V_{dc} = K_a | V_{inv} | \dots \dots \dots 3)$$

Where

$K_a = K * a$, K = Pulse number, a = Ratio of the coupling transformer

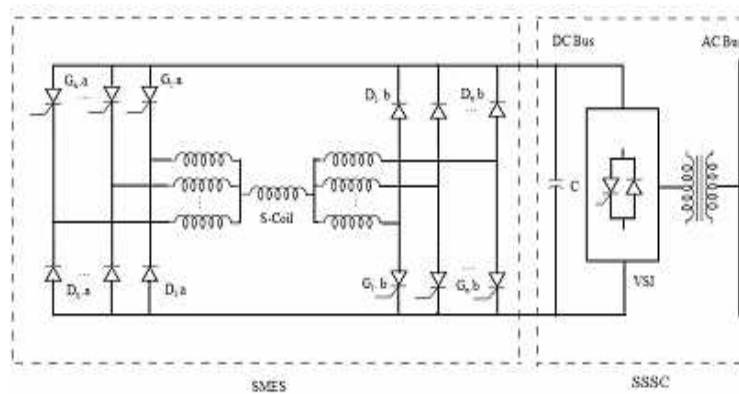


Fig.4.Circuit diagram for Chopper

RESULT AND DISCUSSION

Test System

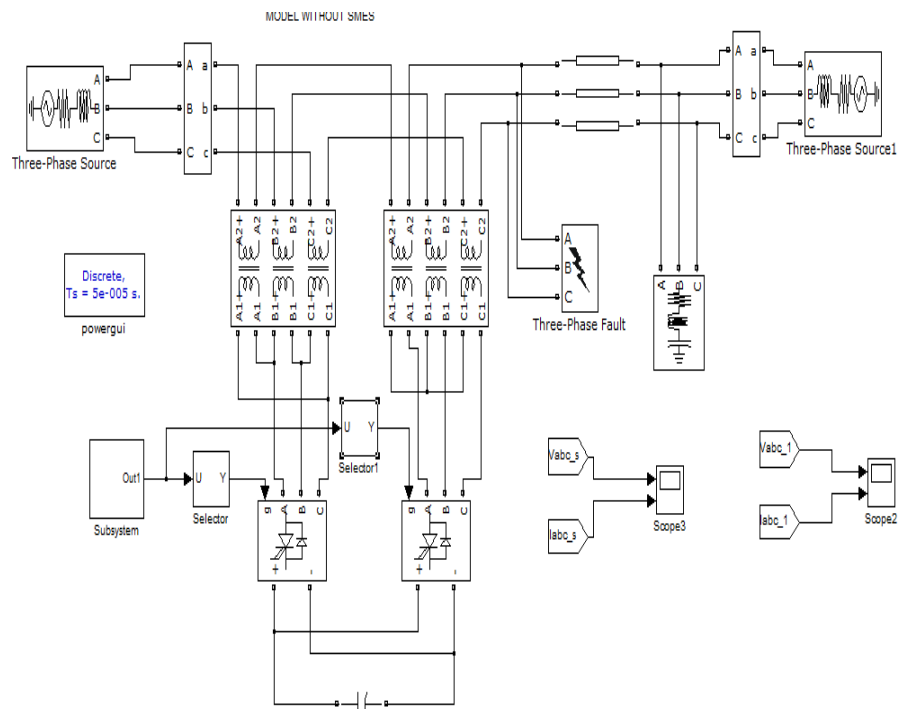


Fig.5 Test system for voltage stability Enhancement

From fig.6 It is analyzed with two cases (a) and (b), Case (a) is discussed with SSSC and case (b) without SMES is analyzed with SSSC with SMES. In the test system the three phase fault is simulated and the test results are obtained for the voltage and current and the results are analyzed for with and without SMES.

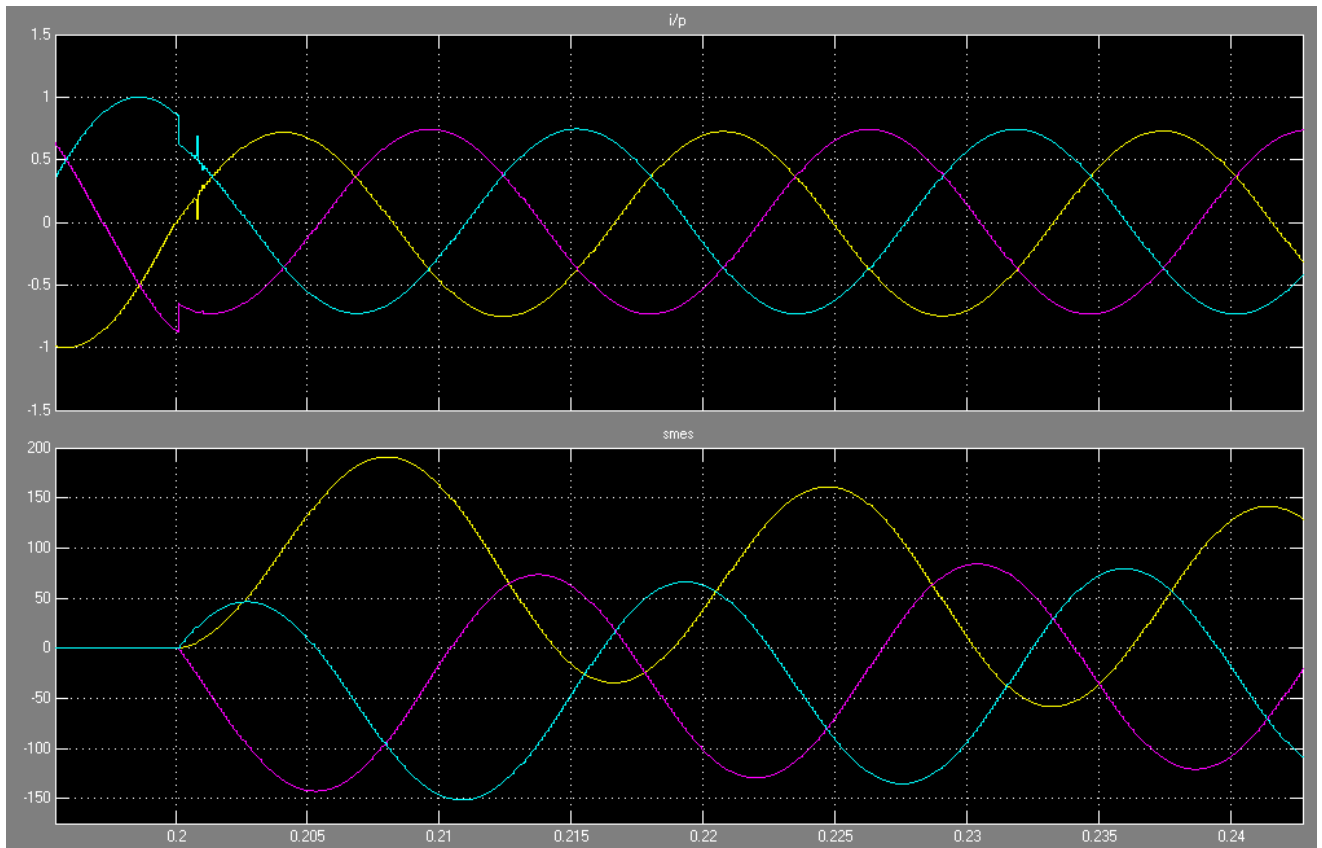


Fig.6 .Simulation result with SMES

From fig.6, it is clear that, at the voltage stability increase in case (b) compare with case (a). settling time for test system with fault, case (a) and case (b) are 0.125sec, 0.045sec and 0.035sec respectively. From this, we observe settling time for case (b) is minimum. Simulation output of current for the test system with fault and both cases output is shown in Fig. 6. Settling time of current for test system with fault is 0.385sec, for case (a) 0.105sec, for case (b) 0.04sec correspondingly.

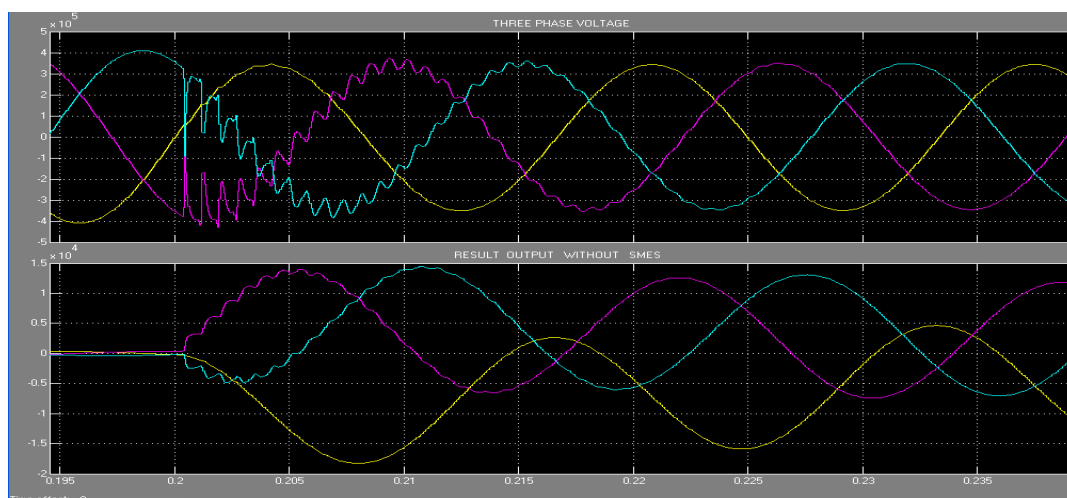


Fig.7 Simulation result without SMES

CONCLUSION

The dynamic performance of the SSSC with and without SMES for the test system are analysed with Matlab/simulink. SMES with two quadrant chopper control plays an important role in real power exchange. SSSC with and without has been developed to improve transient stability performance of the power system. It is inferred from the results that the SSSC with SMES is very efficient in transient stability enhancement and effective in damping power oscillations and to maintain power flow through transmission lines after the disturbances.

ACKNOWLEDGEMENT

We are very much thankful to professor A.M.Mulla for become a constant source of energy during our project work.

REFERENCES

- [1] S. S. Choi, F. Jiang and G. Shrestha, "Suppression of transmission system oscillations by thyristor controlled series compensation", IEE Proc., Vol.GTD-143, No.1, **1996**, pp 7-12.
- [2] M.W. Tsang and D. Sutanto, "Power System Stabiliser using Energy Storage", 0-7803-5935-6/00 **2000**, IEEE
- [3] Hingorani, N.G., "Role of FACTS in a Deregulated Market," Proc. IEEE Power Engineering Society Winter Meeting, Seattle, WA, USA, **2006**, pp. 1-6.
- [4] Molina, M.G. and P. E. Mercado, "Modeling of a Static Synchronous Compensator with Superconducting Magnetic Energy Storage for Applications on Frequency Control", Proc. VIII SEPOPE, Brasilia, Brazil, **2002**, pp. 17-22.
- [5] Molina, M.G. and P. E. Mercado, "New Energy Storage Devices for Applications on Frequency Control of the Power System using FACTS Controllers," Proc. X ERLAC, Iguazú, Argentina, 14.6, **2003**, pp. 1-6.
- [6] Molina, M.G. and P. E. Mercado, "Evaluation of Energy Storage Systems for application in the Frequency Control", Proc. 6th COBEP, Florianópolis, Brazil, **2001**, pp. 479-484.
- [7] M. S. El-Moursi and A. M. Sharaf, "Novel reactive power controllers for STATCOM and SSSC," Electric Power Systems Research, vol. 76, **2006**, 06, pp. 228- 241.
- [8] Padma, S. and Lakshmipathi, R. "A PI controller for enhancing the transient stability of multi pulse inverter based Static Synchronous Series Compensator (SSSC) with Superconducting Magnetic Energy Storage (SMES)", International Journal of Electrical and Electronics Engineering, **2010**, pp. 446- 452.
- [9] Anil. C. Pradhan and P.W. Lehn, "Frequency domain analysis of the static synchronous series compensator," IEEE Transactions on Power Delivery, vol. 21(1), January **2006**, pp. 440-450