Power flow comparisons in a transmission line with UPFC and SSSCs devices

Parvej khan[1] ,Himmat singh [2]

[1/2] *Department of electrical engineering MITS Gwalior*

E-mail:- [1]parvejkhan4834@gmail.com, [2] himmatmind100@yahoo.com

Abstract:-The device SSSCs work in the same way as the STATCOM. It has a voltage source converter (VCS) connected in series to the transmission line through a transformer. It required an energy source to provide a continuous voltage through a condenser and to compensate the losses of the VSC. A SSSC is able to exchange active and reactive power with the transmission system. In this case the serial injected voltage can delay or advanced the line current. This means that the SSSC can be uniformly controlled in any value. In this paper the result thus we obtained by modeling a transmission system in MATLAB SIMULINK by using UPFC and SSSCs (static synchronous series compensator) in first case the upfc is connected to bus B3 and in second case upfc is replaced by sssc and the result obtained from these two case is compared. From these two simulink results we conclude that the sssc gives more suitable results as compared to UPFC.

Keywords— FACTS, (UPFC), AC transmission system, power flow control, STATCOM, SSSC.

I. INTRODUCTION

The **SSSC** when operated with an appropriate DC supply (an energy source and/or sink, or suitable energy storage) can inject a component of voltage in anti-phase with the voltage developed across the line resistance, to counteract the effect of the resistive voltage drop on the power transmission. The capability of the **SSSC** to exchange both active and reactive power makes it possible to compensate for the reactive and resistive voltage drops, maintaining a high effective X/R ratio independently of the degree of series Compensation Thus, a **SSSC** can work like a controllable serial condenser and a serial reactance. The main difference is that the voltage infected through a **SSSC** is not related to the line intensity and can be controlled independently. This important feature means that the **SSSC** can be used with excellent results With low loads as well as with high loads. The transmission line with thee having no compensation of any kind is said to be in steady-state. The voltage impressed by the effective reactance is the same with the voltage drop across the uncompensated line because the degree of series compensations is zero.

The line reactance is constant and by adding variable series (capacitive/inductive) reactance, the amount of compensation can be controlled.

In the inductive mode of operation, the line current decreases as the inductive reactance compensation level increases from 0% to 100%. In the capacitive mode of operation the line current increases with the capacitive reactance compensation level from 0% to 33%. It is worthy to note from the diagrams that **SSSC** not only can increase the transferable power but it can also decrease it, simply by reversing the polarity of the injected voltage. The reversed voltage is added directly to the line voltage drop as if the line impedance was increased. The effects of the compensating reactance on the normalized power flow in the transmission line are as follows: when the emulated reactance is inductive, the active and reactive power flow decrease and the effective reactance increases as the reactance compensation increases in the negative direction, and when the emulated reactance is capacitive the active and reactive power flow increases and the effective reactance decreases as the reactance compensation increases in the positive direction. We can also approve of the general use of a serial controllable condenser in the case of **SSSC** it controls the dynamic energy flow and improves the stability between the angle and the voltage. The capacitive and inductive voltage increases the operation field of the device. During the stability slot the potential of damping electromechanical oscillations increases.

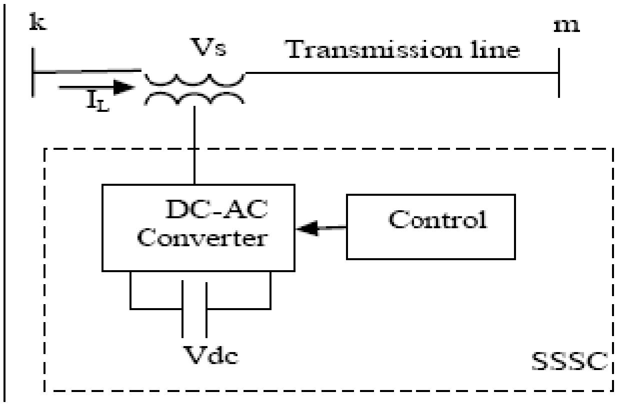


Fig.1 shows the SSSC installed in a transmission line

II. CHARACTERISTICS OF SSSCs:

These devices SSSC correct the voltage when there is a fault in the network but also have a lot of advantages in normal use, when there are no disturbances, like:

- Due to the continuous voltage injection and in combination with a properly structured controller, it is possible to control the power factor of connected loads;
- In the interconnected distribution network topologies, the additional voltage with its controllable magnitude and phase, van be used to work on the power flows.
- It can also help to cover the capacitive reactive power demand if cable networks, which is higher than in aerial lines, mainly during low load periods that cause inadmissible load elevations;
- It balances loads in interconnected distribution networks, providing a balanced system;
- It reduces the harmonics caused because of the use of distributed electrical generation pants at a distribution network level, by active filtering by injecting voltage with the converter at the load side.

III. MODELLING OF SSSCs ON A TRANSMISSION SYSTEM.

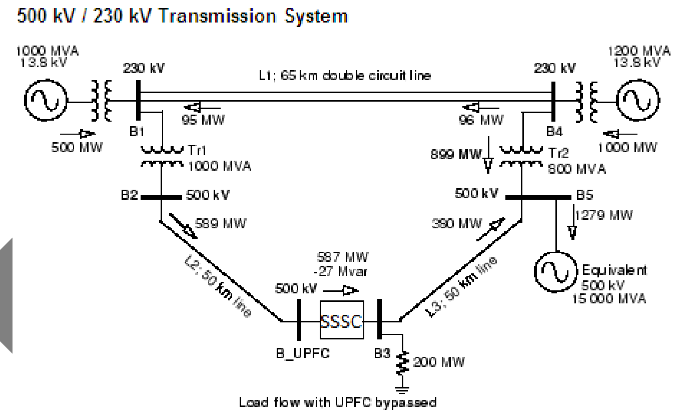


Fig-2 Shows the Single line diagram of a 500kv/230kv transmission system using SSSC.

Using the concept of the control system a power system is taken to implement the use of SSSC. The two modes i.e. the power flow control and the voltage injection mode are simulated in SIMULINK to see the effect SSSC on a power system. Study is carried out to verify the utility of FACT device. The figure below illustrates application study the steady-state and dynamic performance of static synchronous series compensators used to relieve power congestion in a transmission system. The load flow analysis and the single diagram simulation are done on power flow simulator. This software helps to calculate the power flow, voltage at each bus and the cost effectiveness of the system.

IV. DESCRIPTION OF SINGLE LINE DIAGRAM

A SSSC is used to control the power flow in a 500 kV /230 kV transmission systems. The system, connected a loop configuration, consists essentially of five buses (B1 to B5) interconnected through three transmission lines (L1, L2, L3) and two 500 kV/230 kV transformer banks Tr1 and Tr2. Two power plants located on the 230 kV system generate a total of 1500 MW which is transmitted to a 500 kV, 15000 MVA equivalent and to a 200 MW load connected at bus B3. Each plant model includes a speed regulator, excitation system. In normal operation, most of the 1200 MW generation capacity of power plant #2 is exported to the 500 kV equivalents through two 400 MVA transformers connected between buses B4 and B5. The load flow shows that most of the power generated by plant #2 is transmitted through the 800 MVA transformer bank (899 MW out of 1000 MW) and that 96 MW is circulating in the loop. Transformer Tr2 is therefore overloaded by 99 MVA. This will now illustrate how a SSSC can relieve this power congestion. The SSSC located at the right end of line L2 is used control the active and reactive powers at the 500 kV bus B3, as well as the voltage at bus B. The SSSC consist of, IGBT-based, converters (one shunt converter and one series converter interconnected through a DC bus). The series converter can inject a maximum of 10% of nominal line-to-ground voltage (28.87 kV) in series with line L2.

Fig 3: MATLAB Simulink model of above single line diagram of above transmission system using UPFC.

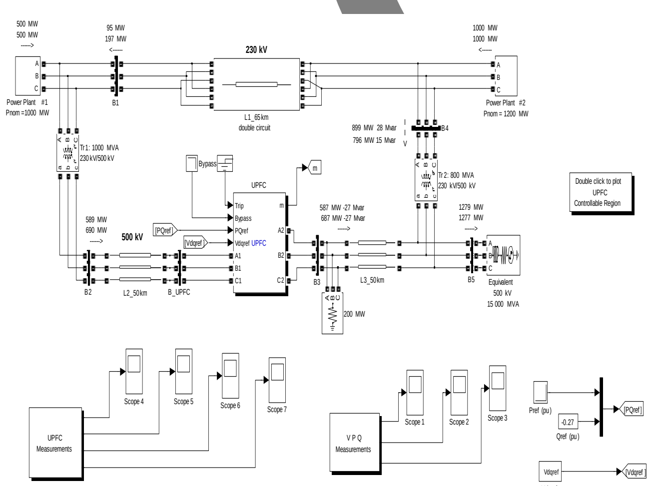
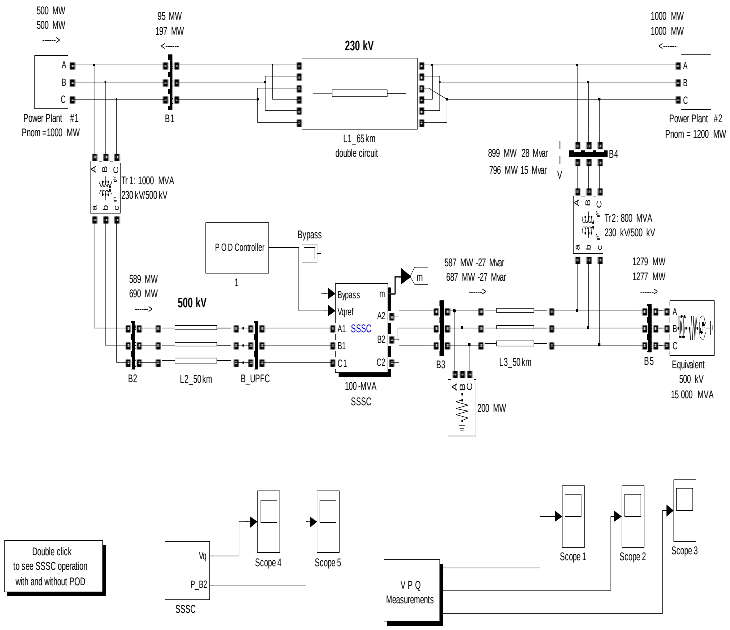
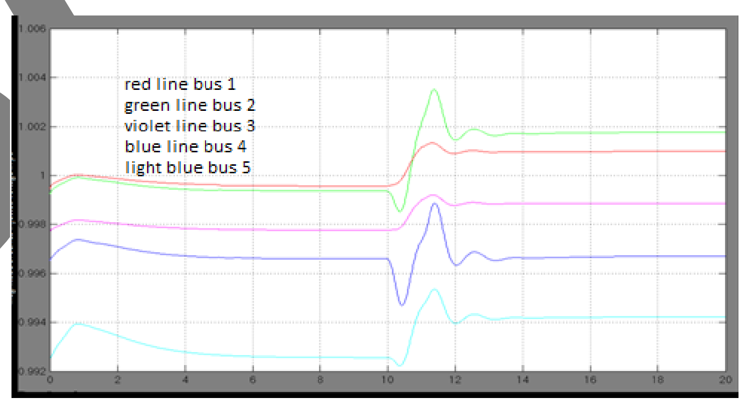


Fig 4: MATLAB Simulink model of above single line diagram of above transmission system using SSSC.



Series injected voltage in pu through a (VSIs) connected in series to the transmission line Through a series transformer using UPFC.

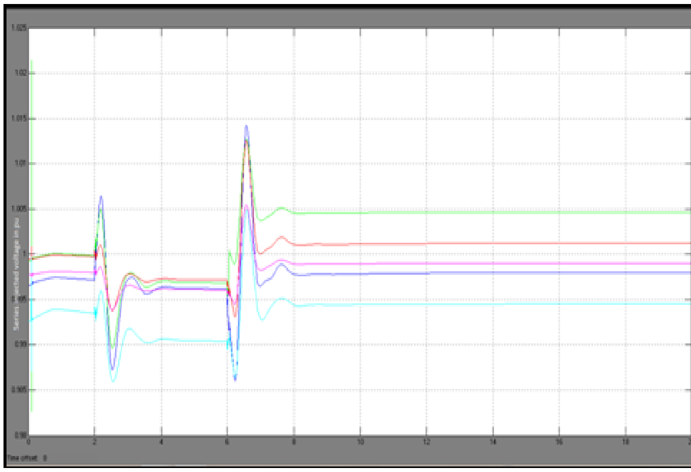
Note: X-axis represents the time in second and Y axis represents series injected voltage in pu.



Graphical result with UPFC

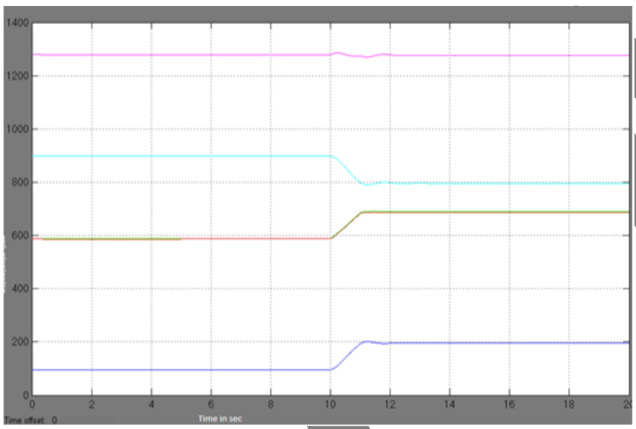
Series injected voltage in pu through a (VSIs) connected in series to the transmission line Through a series transformer using SSSC.

Graphical result with SSSC



Graphical results shows the comparison between the real power flows in the transmission line with UPFC and SSSC.

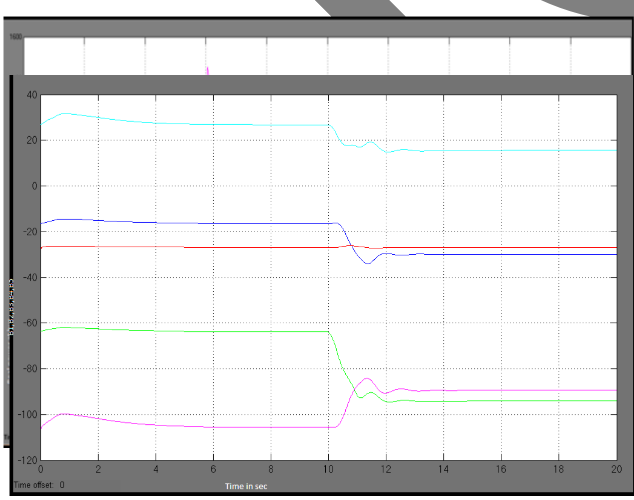
Note :- here Y-axis represents the real power in MW



Graphical result with UPFC

Graphical result shows the Comparison between reactive power flows in the transmission line with UPFC and SSSC.

Note:-here the Y-axis represents the reactive power in MVAR.

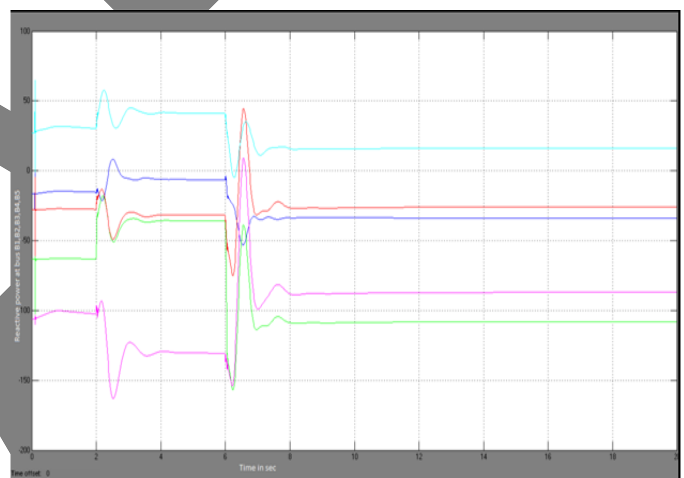


Graphical result with UPFC

Graphical result with SSSC

V. RESULTS:

In the single line diagram the (SSSC) is connected to bus B_3 and the result thus we obtain shows the comparison between the real and reactive power flow in the transmission line by using UPFC and SSSC to bus B3. By using UPFC the real power of bus B3 is increased by 100MW i.e. 687MW and reactive power is -27MVAR and remain constant up to t=20sec but with the use of SSSC for a series voltage



injection from 0.980 to1.025 pu the injected voltage start varying at a rate of 45deg/sec the (SSSC) active and reactive power are set in magenta blocks labelled Pref(pu) and Qref(pu) initially the breaker is closed then the power flow in bus B3 is remain unaffected but when the breaker is opened the active and reactive power start oscillating at t=2sec the real power decrease by 190MW and again increased up to 487MW and remain constant up to t=6sec at t=6sec it again increased by 200MW and again decreases to 687 MW the reactive power up to t=2sec is -27 MVAR and at t=2sec reactive power increases up to 10 MVAR and remain constant up to t=6sec after t=6sec it again start decreasing and decreases up to -50 MVAR and again increases at t=8 sec the reactive power remain constant i.e -27 MVAR up to t=20 sec the oscillation in reactive power was finished at t=8 sec. thereby we find that the use of UPFC provide much better result as compared to the use of SSSC.

VI. CONCLUSIONS:

It is necessary to maintain the voltage magnitude, phase angle and line impedance of the transmission line in this paper a three phase transmission system is simulated in MATLAB ones by using UPFC and again by using SSSC this paper presents the control and performance of UPFC used for power quality improvement the real and reactive power increases with the increase in angle of series voltage injection. The simulation result thus we obtained by introducing UPFC into transmission system provide better result as compared to the result obtain by using SSSC into the transmission system. in case of SSSC device for a little variation in series injected voltage the real and reactive power start oscillating widely so in order to maintain voltage magnitude phase angle and line impedance of the transmission line the use of UPFC gives better result as compared to using SSSC.

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