Voltage Control in a Power System with the Help of Reactive Power Control

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Abstract

To deliver the active power (watt) through the transmission lines, the reactive power (Var) is necessary to maintain the voltage. In case of voltage sag reactive power support, voltage can be restored. Also, to regulate the power factor of the system and maintain voltage stability, we need to replenish the reactive power. Due to the decrease in the load voltage and the change in the load, the change in the voltage level in the system causes the increase in the demand for reactive power. If this demand is not completed by the electricity system, then the voltage decreases again. Due to the voltage of these components, there is a rapid decrease in the voltage at a particular location. The lack of this voltage of the special place will have an effect on the surrounding areas, which can be due to further voltage collapse. This project describes a model in which a coordinated and interconnected set was placed in the form of controlled shunt and series elements. For each device, functional features, specific settings and controls, and simulation examples are presented. The model is capable of representing almost any facts device for power-flow and all type of simulation.
Keywords- Matlab/Simulink and Power-World

I. INTRODUCTION

In electrical system, the power is expressed as the product voltage and current in a circuit and the phase angle difference between them, but further it is of two types active power and the reactive power. the active power is the visible power to load and Reactive power is one of the most important factors in the system, various important electrical machinery such as induction motor, transformation Due to the work of various electrical appliances such as die, refrigerator, microwave oven etc. should be maintained in the system. Widely things if we take utility of reactive power in the power system, it is increasingly necessary, because it is necessary to transfer power for the reactive power should be maintained. Reactive power is necessary but managing it correctly is an essential task.

So, first we start with a simple understanding. This electric power consists mainly of two components, is an active power and the second is a reactant power, because according to the convention, the active power is easily visible for the eyes as the bulb shines. Electricity is lost in the load in the form of heat, or mechanical motion has been changed.

However, in the AC circuit, compacts like capacitors and inductor store a part of the electrical power inside them, which, in a period, gradually rotates between the source and between loads like inductive load or capacitive load. Periodic reversal of the direction of flow of energy is mainly called as reactive power in the system. Here a part of the power is stored temporarily, which periodically comes in flow from the capacitor electrostatic field for periodic load in the system, mainly due to the reactive power, electromagnetic devices such as induction machine, transformer or reactive load demands inductive the lack of current while electrostatic device leading the reactive current on general. Reactive power is an unused portion of the system, which is present in the system for transfer of power from one circuit to another circuit. Indicators are a reactive power absorbing source, it can be found by the fact that whenever we apply a voltage to the inductive device, it first creates a magnetic field and then the voltage is with the lower phase angle. Running after a certain interval of time the current reaches its peak current.

Similar is the story of capacitors, they are accumulating electrical energy in the electrostatic field in their circuits, but if we apply a voltage to the circuit then the voltage is formed and the charge is stored in the capacitors. And the voltage is being developed in capacitors plates. It is obvious that the capacitor absorbs the major current from the system and therefore we can say that if the current passes through the inductor then it gives its proven reactive power which is cool in nature and if the current passes through the capacitor it provides capacitive reactive power which is a pioneer in nature.

To write an equation for power expression in an inductive circuit, we have the following expression for the power that has been assigned to the load.
Let the supply voltage to be = V
And the supply current to be = I
And the electrical power = P
The phase angle difference = θ
And supply angular frequency to be = ω
Then the power equation to the inductive load can be written as,

$$P = VmaxImaxCos\omega t\, Cos(\omega t - \theta)$$

So mathematically this equation can be decimated in two parts. Active component which is

$$\frac{VmaxImaxCos\omega t}{2} Cos\theta(1 + Cos2\omega t)$$

And the Reactive components is,

$$\frac{VmaxImaxCos\omega t}{2} Sin\theta(1 + Sin2\omega t)$$

Therefore, obviously, the reactive components and active components are quadrature for each other and the angle between them is the power factor angle, the factor of the less power is the power and transfer to the active energy.

The voltage in the industrial zone is often one of the more frequent and pressing problems. IEEE defines voltage attachments because defaults in the root route mean that the square voltage of the basic voltage wave between the ranges of 1 PU to the range of 0.9pu-1pu for a half cycle.

Below are the main reasons for voltage Sag.

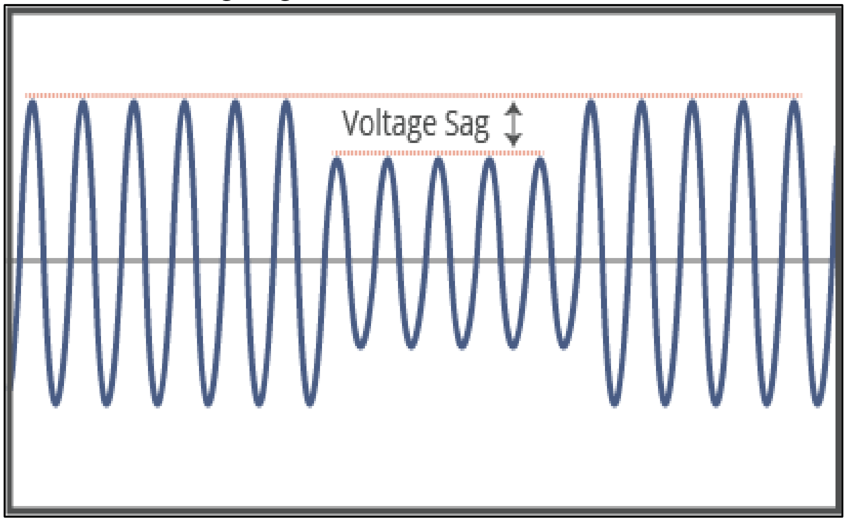


Fig. 1: Voltage Sag

II. ESSENCE OF REACTIVE POWER COMPENSATION

Reactive power compensation is required due to the fact that the power shift from one end to another involves both active power and reactive power. As we know that vector zodiac is of two vectors which is active power and reactive power, gives total power in the circuit. But the thing is that we do not need to include reactive power because it can benefit from other sources because it is going to be in the form of unused power in the system, which is getting oscillated in the system and source in the line. The generator does not need to supply the reactive power itself and the angle of the cosine between the reactive power and the active power gives the power factor angle. The lesser angle will be more efficiently transmitted. Hence the power of the reactive power committees is the main objective in the less acceptable unit range Factor angle is to maintain. But the reactive power is an essential part of the system. Without it, power cannot be transferred from one circuit to another. Instead of being supplied by the generator, we have to give reactive VAR to the system in the midst of the system without drawing from the generator. Therefore, it will reduce the power generation capacity of the generating station and therefore saves precious fuel and energy resources. Therefore, to rectify the above-mentioned point, reactive power is being compensated due to the following points.

- Reactive power compensation provides better voltage regulation capability.
- Stability of system increases significantly.
- The use factor of the machine connected to the AC system increases.
- To prevent unrest voltage greens with voltage as well.

III. BRIEFING ON FACTS DEVICE

Facts or flexible AC transmission devices are electrical electronics-based compensation devices that are designed to reciprocate the real power between the reactive power or device and the system, hence helping to contribute to stability of the device and transient stability. We do. The heart of the real devices are electric electronics switches based devices. They do all the necessary functions for the evaluation process. Fact devices are famous and limestone come in the form of light because of their excellent work capacity and rapid switching reaction and due to the functions.

Below are various types of facts VAR generators can be listed. Here we will see various possible methods and compensation options available for compensation for reactive VAR compensation.

FACTS devices used nowadays are:

A. Various Var Generator

1) Synchronous condenser
2) Capacitor bank
3) Thyristor operated Var generator
– Thyristor switched capacitor (TSCS)
– Thyristor controlled reactor (TCRS)
– Combination of the TSCS and TCRS
– Thyristor controlled series capacitor

B. The Self-Commutated Var Generator are Including some of the Fact Devices

1) Static synchronous compensator (STATCOM)
2) Static synchronous series compensator (SSSC)
3) Unified power flow controllers (UPFC)
4) Dynamic voltage restores (DVR)

IV. RECENT DEVELOPMENTS

This voltage presents the test of time-ratio controlled autotransformer as a relief gadget for all stimulation. The circuit is used in the control of the circuit account load RMS and voltage list in view of the top recognition. Normally the dynamic voltage restorer and STATCOM are used for the restraint of voltage sag. The gadget is used to make PWM signal pulses, in order to isolate the required voltage of the auto transformer, the account time-ratio control is taken in order to increase load voltage demand. The voltage is rapidly identified by using peak detection circuit, which constantly assesses the top hide of the supply voltage. The salvage gadget is straightforward in development and includes a secluded PWM insulated gate bipolar transistor (IGBT) switch, a scaffold design, a theoretical spacing switch, an autotransformer, and a voltage controller in every step. In this way, it is less versatile than the used DVR and STATSOM.

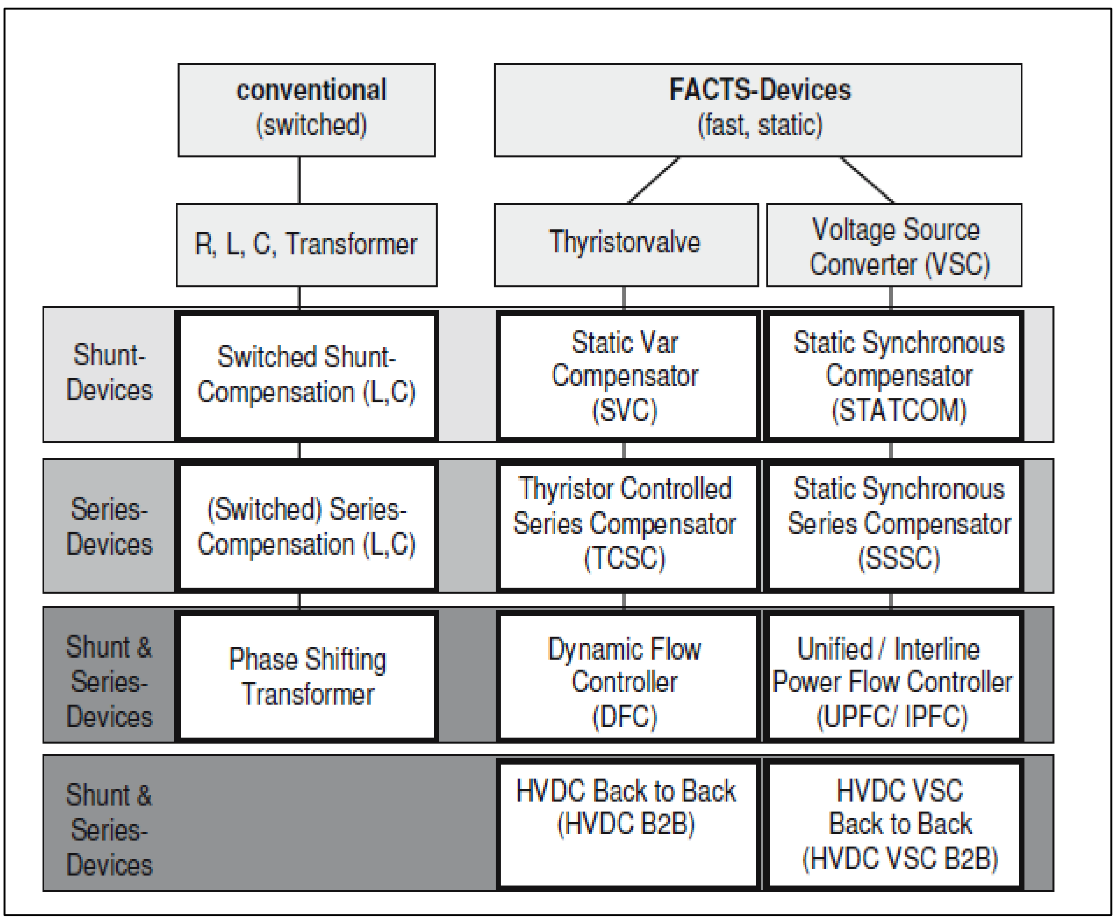


Fig. 2: Overview of major FACTS-Devices

V. LITERATURE REVIEW SURVEY

A. Power system stability and control "CH-14 Voltage Stability"

By PRABHA KUNDUR, TATA McGRAW-HILL Voltage stability problems normally occur in heavily stressed system. While the disturbance leading to voltage collapse may be initiated by a variety of causes, the underlying problem is an inherent weakness in the power system. In this section illustrate the basic concept related to voltage instability by firstly considering the characteristics of transmission systems and then examining how the phenomenon is influenced by the characteristic of generator, loads and reactive power compensation device.

B. Power system stability and control "CH-11 Control of Active Power and Reactive Power"

By PRABHA KUNDUR, TATA McGRAW-HILL This chapter will examine control of active power and reactive power by considering the system as an entity. In addition, the characteristics and modeling of equipment used for control will be described. Capacitors supply reactive power and boost local voltages. They are used throughout the system and are applied a wide range of sizes.

C. Simulation and Comparison of various facts devices in power system

Research works are going on in finding newer concept for minimizing the reason of voltage collapse by increasing voltage stability (Dynamic, Transient and Steady-state stability), voltage margin and voltage security in the system. Voltage collapse is a major problem of power system and it occurs due to voltage instability. There are many analysis methods for determining voltage stability based on power flow. Steady- state stability is the ability of power system to control after small disturbances.

FACTS (Flexible alternating current transmission system) are mainly used for solving instability problems. Recently it has been noted that FACTS controllers can also be used for power flow control and stability enhancement control.

VI. BASIC DESCRIPTION OF FACTS DEVICES

– Fixed Capacitor Thyristor Controlled Reactor (FC-TCR)

Static VAR Compensation Devices are the most important tools and have been used for many years to improve the voltage and power flow through the transmission line by solving the dynamic voltage problems. The static generator / absorber associated with the SVC shunt is the utility of the SVC controller in the transmission line. There are many:

1) Stable-state and transient voltage provides high performance in stability control
2) Reduces power swing
3) System damage Reduce
4) Control the actual and reactive power flux

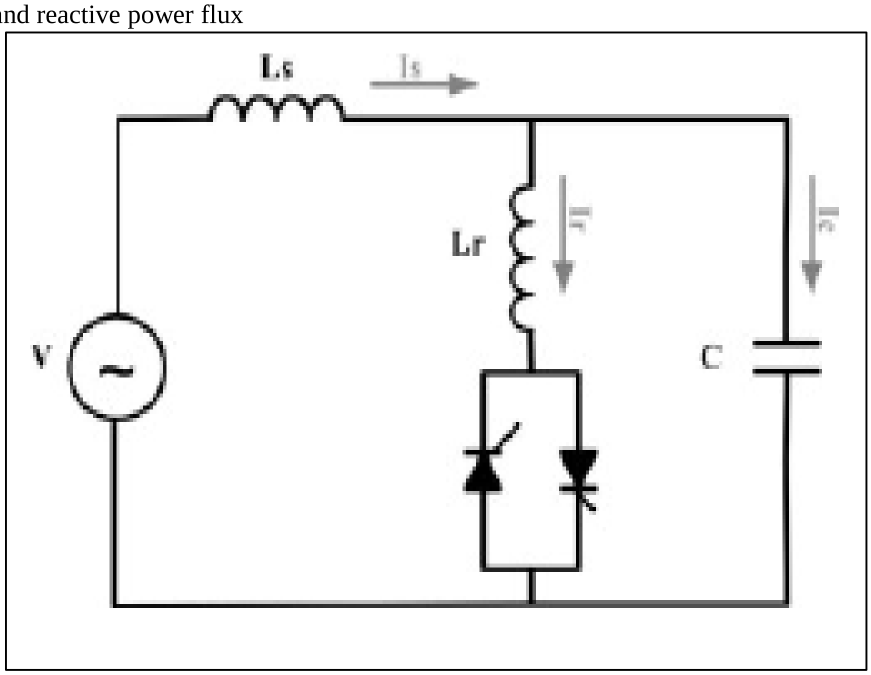


Fig. 3: FC-TCR

– Static synchronous compensator (STATCOM)

Static Synchronous Compensator (STATCOM) is a shunt connected GTO based facts device. STATCOM is a static synchronous generator that is operated as a static VAR compensator, which can inject the interval or leading version in the system. There are many advantages of STATCOM: There are no moving parts in it, much faster in response, less space is required because heavy passive components are eliminated, naturally modular and restoration, less maintenance and any problems related to synchronization loss is not. Simple drawing of STATCOM is shown in Figure. The DC source voltage is inserted into the AC voltage through the transformer using voltage source converter using GTO and AC voltage. In the heavy load condition, if the output line of VSC is higher than the voltage, the converter supplies the duct reduction to the transmission line. If the line voltage is high during low load conditions then the converter absorbs the VAR behind the system.

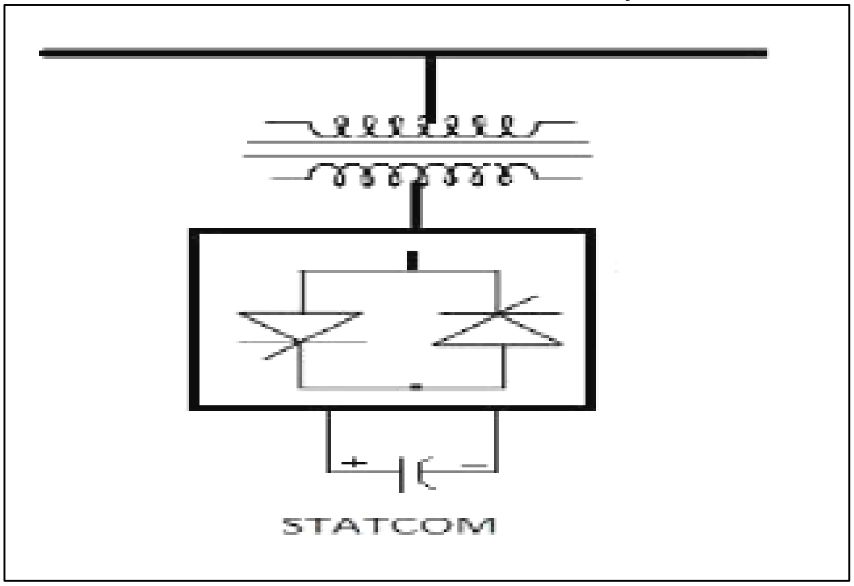


Fig. 4: STATCOM

– Thyristor controlled series capacitor (TCSC)

Thyristor Controlled Series Capacitor (TCS) is an important series compensator like SSSC. In particular, in these facts (flexible alternate transmission system), the gate of the gate does not require a throttle. Figure 3 Figure 3 shows the schematic diagram of a TCSC controller. In TCS, the capacitor is inserted directly into the transmission line and TCR is kept in parallel with the capacitor. As the capacitor is inserted in line with the line, there is no need to use high voltage transformer and thus it provides a better economy. The backing angle behind the background is controlled to control the reactor. On 180 degree firing angle TCR, non-operable and TCR at full 90 degree firing angle is in full operation.

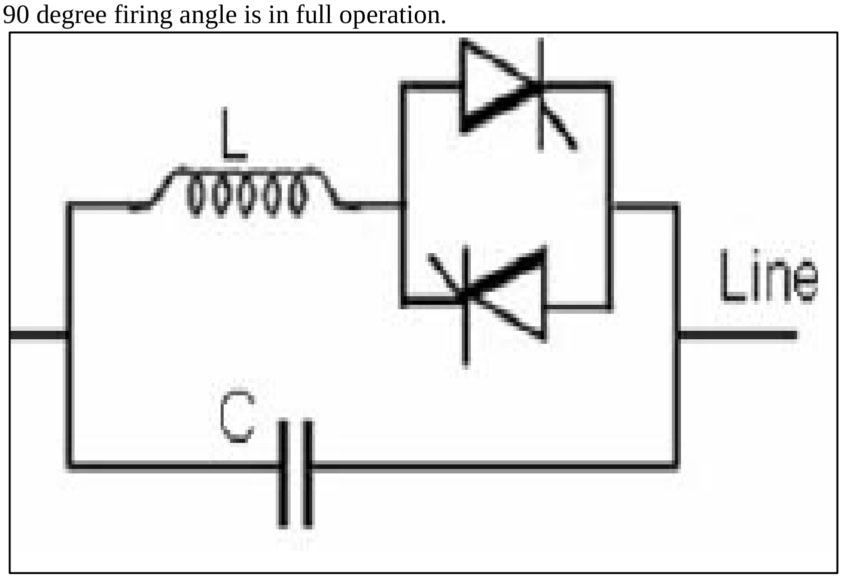


Fig. 5: TCSC

– Static synchronous series compensator (SSSC)

In the present days, the SSSC power series is one of the most important facts controllers used for compensation. In the series compensation, the capacitor connected to the series compensates for the inductive reaction of the transmission line. The SSSC output voltage (VC) line is quadrupled with current (I) voltage in the series capacitor- Jxcl (where the axis is capacitor's capacitor reactor) and the voltage drop in the line installation (XL) + Jxil can cancel each other so that the line the effects of the installation can be reduced.

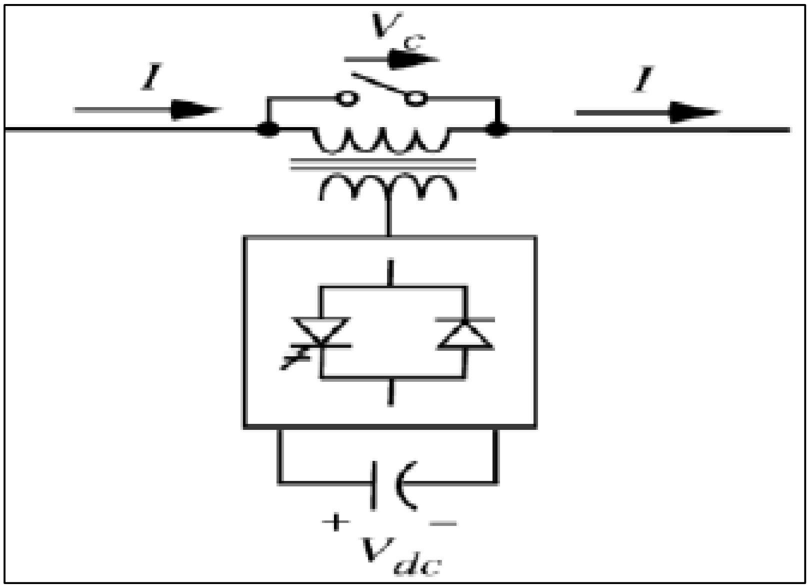


Fig. 6: SSSC

VII. PERFORMANCE ANALYSIS OF CAPACITOR BANK AS A FACTS DEVICE

During the first years of the 20th century, the electric grid was introduced to capacitor banks. At that time, the turn of the electricity network soon became very big and due to the reactive power the damage became a problem.

In this chapter an electro technical statement of capacitor banks is presented in the power network. As with capacitor banks, guidelines and regulations, providing an optimum and practical solution for responsive power compensation will be presented.

Capacitor banks can be used in many ways within the electrical power system. Capacitors connected to parallel to the grid are called Shunt Power Capacitors. In this section, its functions and characteristics have been described.

Capacitor banks are classified as shunt capacitors banks or series capacitor banks in relation to electric networks. Later, to achieve a more efficient power transmission, it is used to modify the transmission lines impedance. This project will deal with capacitor banks completely because it is the technical device selected for reactive power compensation.

Capacitors are made of bank capacitor units, which in turn are made by several capacitor elements. Capacitor units have evaluated the voltage by adding them from the series 240V to 24940V, they can be designed for any voltage level.

A. Benefits of Capacitor Banks

The capacitor bank voltage support in the electric grid, the diversified support, the increase in system capacity, reducing system power loss and reducing the billing charges are the primary benefits for the first two transmission systems, and are important for the last three delivery systems. Capacitor Banks can be classified about their work. Each of them may have some special features which are explained in this section.

B. Voltage Support

In the power buses, the application of capacitor banks leads to the rise of their voltage. The capacitor reduces the stimulus current, which increases the voltage source back and voltage source beyond the capacitor in a radial system.

The increase of the voltage at the capacitor space is approximately equal to the motivational reaction of the system at the capacitor location for the current time of Capacitor.

In the transmission system, capacitor banks are installed on major buses to provide voltage support for large areas. If they are installed in distribution buses, they provide voltage support to small areas and individual customers. Capacitors banks, which are installed for voltage support, are usually closed during peak loading period or low voltage conditions and are discontinued during light loading period or high-voltage conditions.

C. Var Support

Reactive power (var) support means that the features related to reactive power which can work for a capacitor bank. That is, better voltage control and power factor; Reduce system losses and reactive power requirements on the generator.

However, for the supply of maximum reactive power, the capacitor size and transmission and distribution should be located properly in the substation. Unfortunately, Reactive power cannot travel long distances.

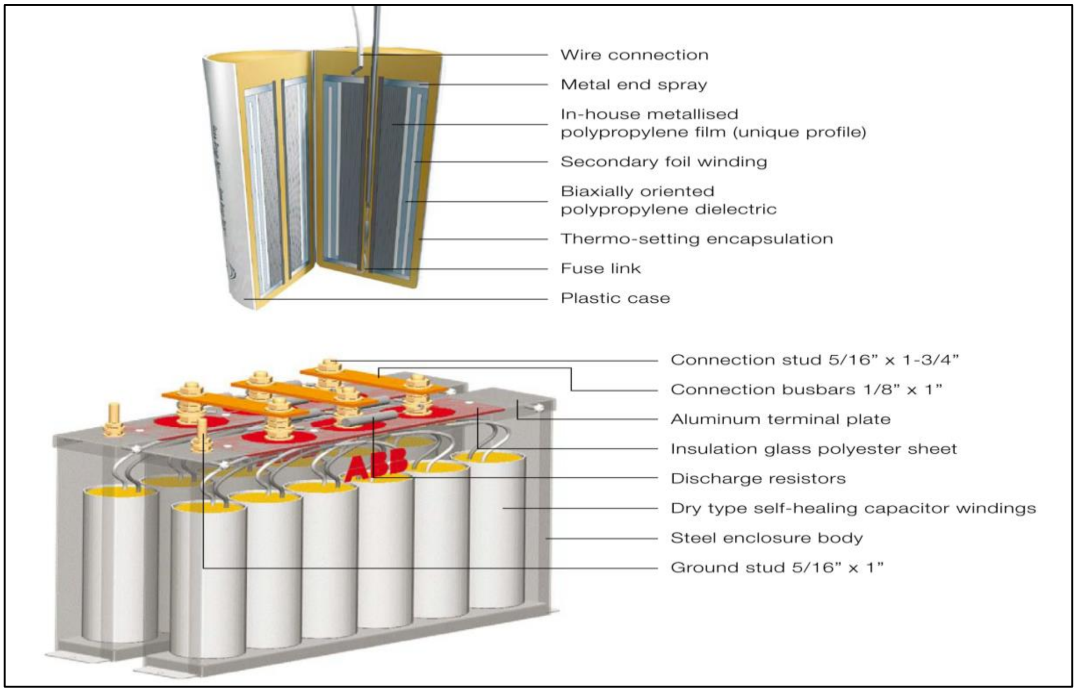


Fig. 7: Capacitor Bank

D. Simulation

The basic transmission of a decisive system (11 KV) model shows that this model has current measurement blocks, voltage measurement blocks, real and reactive power blocks and scopes. 11 kV voltage is supplied to the system from the AC voltage source. Simulation is done using MATLAB / SIMULINK the current measurement block is used to measure the instantaneous source and current load flowing through the transmission line, the voltage measurement block is used to measure the source and load voltage. Is done. The actual and reactive power in the load side is measured using the active and reactive power measurement block. Displays the result after scope simulation The model provides up to four scope: a source displays the voltage (V) and the source current (I), the second shows a real (P) and reactive (Q) power, and the third one The real and reactive power flux received after the simulation after the load voltage (V1) and load current(I1) are shown.

We have to provide reactive power compensation In this project, to achieve better performance about voltage stability, five compensation devices have been studied and comparisons are made to compare the equipment for the discovery of any device that is operating Performs best under position. All plots for the compensation system are shown for a special capacitor value of 40μF.

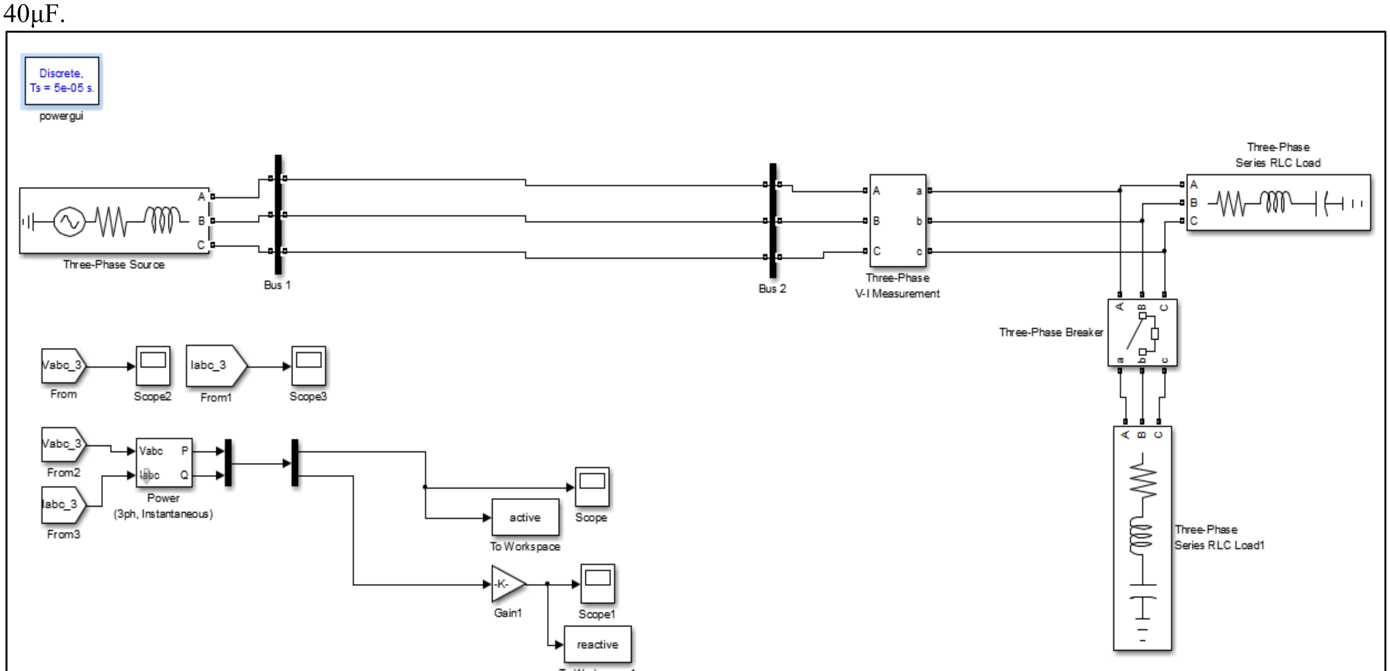


Fig. 8: Uncompensated system

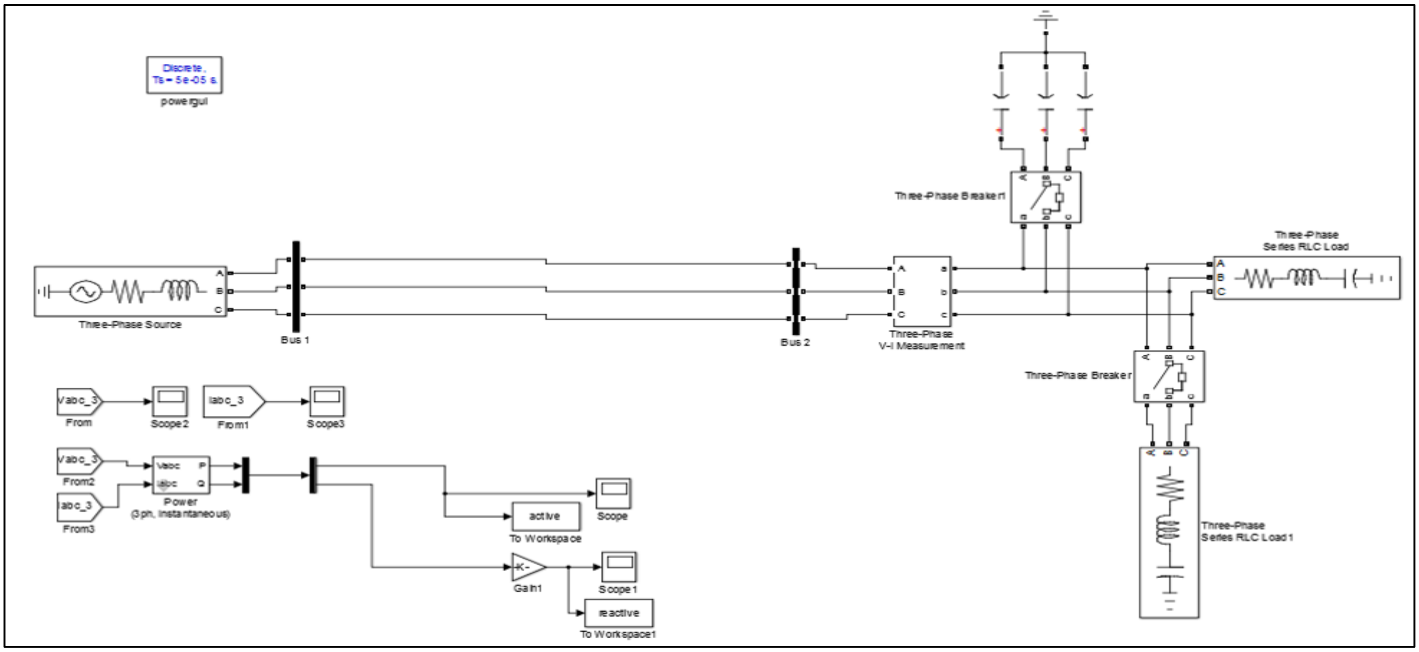


Fig. 9: Compensated System

– Simulation Results

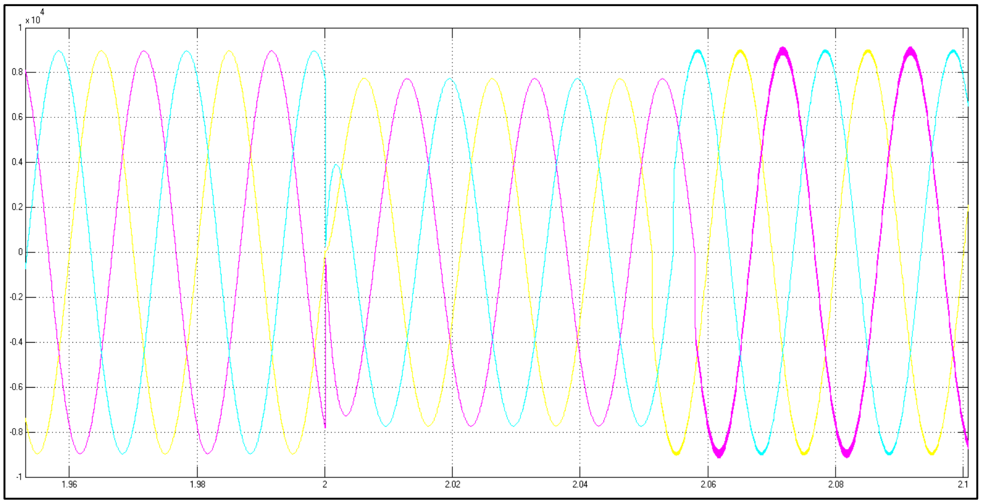


Fig. 10: Graph of Vabc without Capacitor Bank

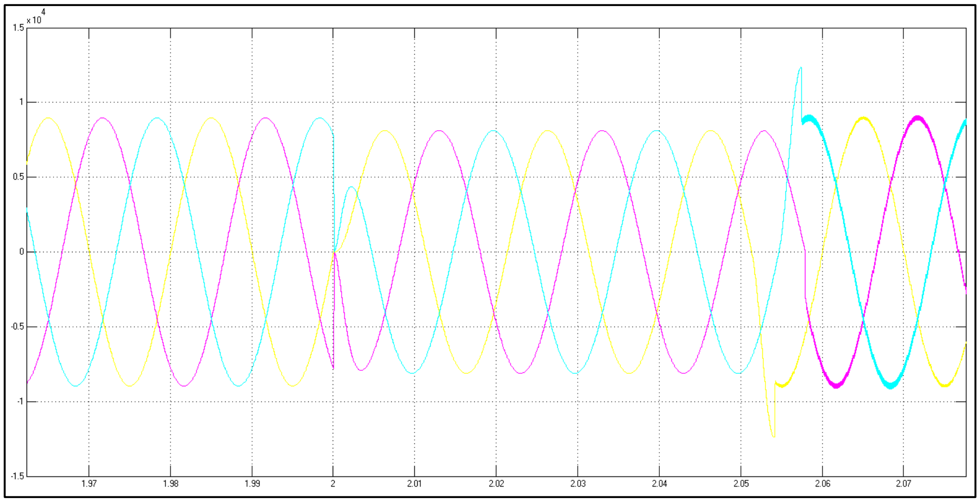


Fig. 11: Graph of Vabc with Capacitor Bank

VIII. PERFORMANCE ANALYSIS OF STATIC VAR COMPENSATOR AS A FACTS DEVICE

A static VAR compensator is a set of power tools to provide fast-active reactive power over high-voltage power transmission networks. SVC flexible AC transmission systems are part of the device family, which regulate voltage, power factor, harmonics and system to stabilize. Unlike a synchronous condenser, which is a rotating electrical machine, a static VAR compensator does not have any significant moving (except for internal switchgear). Prior to the SVC invention, the power factor compensation used to protect large rotating machines such as synchronous condenser or switched capacitor bank.

SVC is an automatic impedance matching device, designed to bring the system closer to the Unity power factor. SVC is used in two main situations.

– To regulate the transmission voltage ("Transmission SVC"), is connected to the power system.
– To improve the quality of electricity ("Industrial SVC") is connected near large industrial loads

In transmission applications, SVC grid voltage is used to regulate. If the reactant load capacitive (pioneer) of the power system is used, then the SVC will use the theoretic controlled reactors to consume the VAR from the system, to reduce system voltage. Under the persistent (cold) conditions, the capacitor banks automatically shut down, thus providing a higher system voltage. By adding the theorist control reactor, which is the constant variable, along with a capacitor bank phase, the net result is the constant variable or leading power.

A. IEEE 9-Bus Modified Test System using SVC

In the IEEE 9-Bus Modified Test System, there are 3 synchronous machines with IEEE type-1 stimulant. There are 12 buses, 6 transmission lines, 6 transformers and 3 revolutions impedance loads. Total load demand is 315 MW and 115 MVAR.

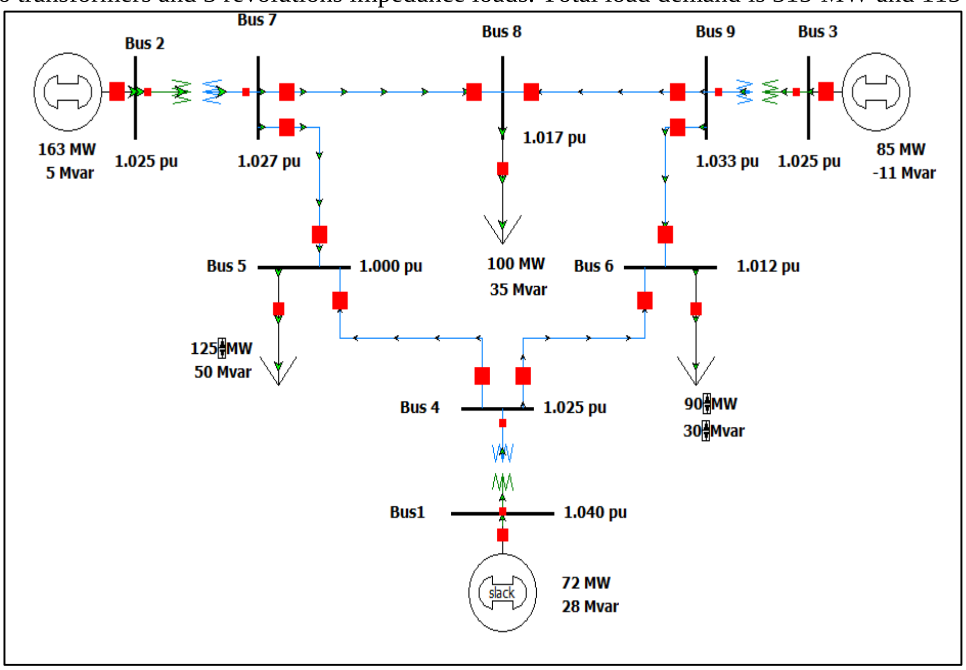


Fig. 12: IEEE 9-Bus System with 3 Constant Load

Table 1: Record of Bus Data when load is maintained

Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar
1	Bus1	1	16.5	1.04	17.16	0			71.63	27.91
2	Bus 2	1	18	1.025	18.45	9.35			163	4.9
3	Bus 3	1	13.8	1.025	14.145	5.14			85	-11.45
4	Bus 4	1	230	1.02531	235.821	-2.22				
5	Bus 5	1	230	0.99972	229.936	-3.68	125	50		
6	Bus 6	1	230	1.01225	232.819	-3.57	90	30		
7	Bus 7	1	230	1.02683	236.171	3.8				
8	Bus 8	1	230	1.01727	233.971	1.34	100	35		
9	Bus 9	1	230	1.03269	237.519	2.44				

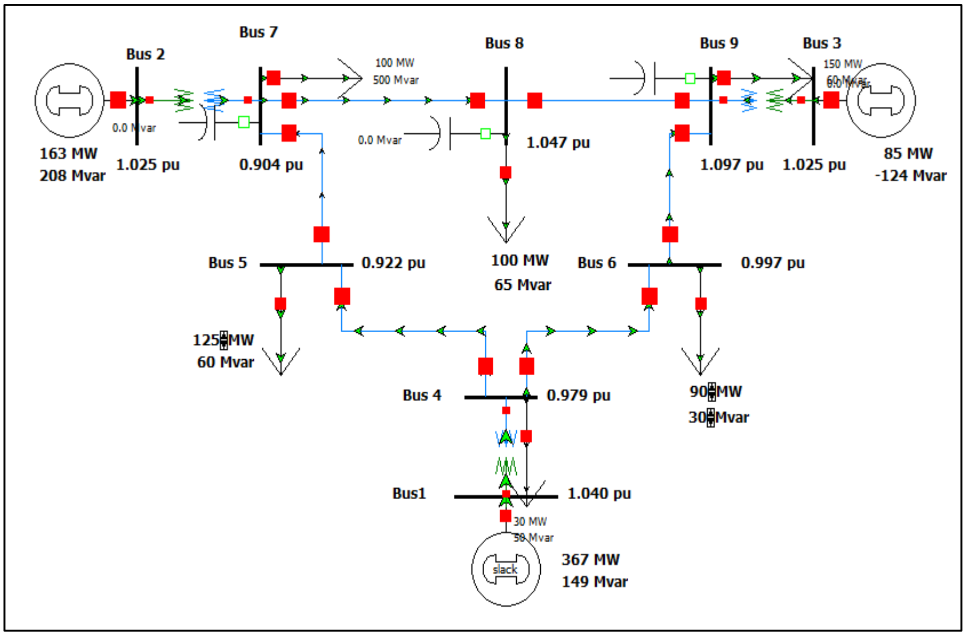


Fig. 13: IEEE 9-Bus System with Constant Load at All Bus

Table 2: Record of Bus Data when load is connected to all bus

Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar
1	Bus1	1	16.5	1.04	17.16	0			369.76	340.06
2	Bus 2	1	18	1.025	18.45	-18.14			163	662.46
3	Bus 3	1	13.8	1.025	14.145	-33.66			85	289.65
4	Bus 4	1	230	0.87593	201.465	-13.52	30	50		
5	Bus 5	1	230	0.75509	173.67	-22.2	125	60		
6	Bus 6	1	230	0.83359	191.726	-25.68	90	30		
7	Bus 7	1	230	0.62896	144.662	-27.23	97.48	487.4		
8	Bus 8	1	230	0.66986	154.068	-35.66	99.54	64.7		
9	Bus 9	1	230	0.86078	197.979	-36.89	150	60		

– From above Results we can say that when the load is maintained on 3bus at that time the value of Pu volt is near about 1 and when the load is connected to all bus at that time the value of Pu volt was decreasing. To maintain the reactive-power we placed a SVC on bus.

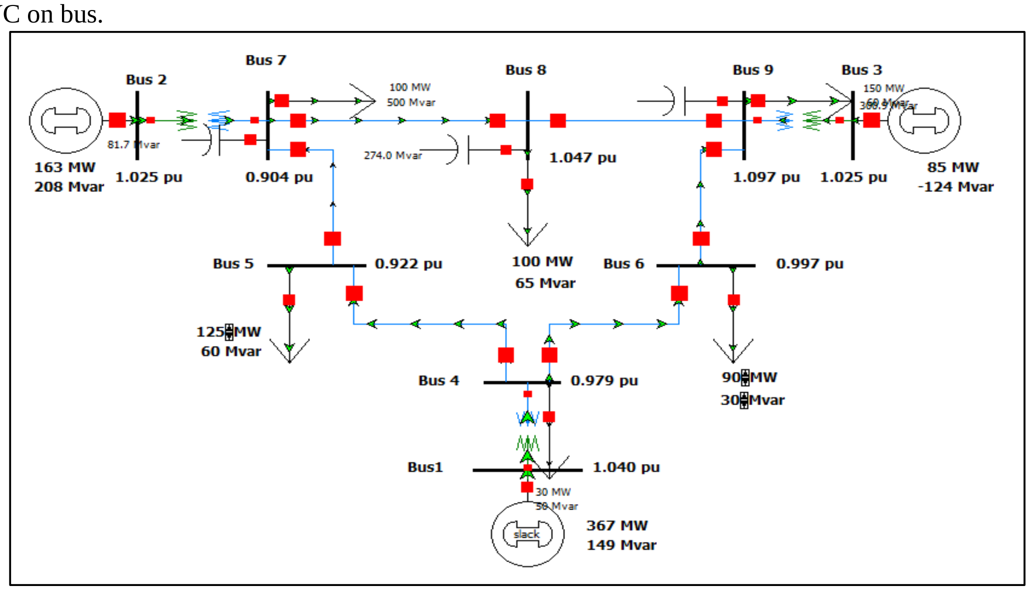


Fig. 14: IEEE 9-Bus System with Constant Load at All Bus (With SVC)

Table 3: Record of Bus Data when put SVC on bus no. 7 at that time control bus 4 & 9

Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar
1	Bus1	1	16.5	1.04	17.16	0			364.99	270.66
2	Bus 2	1	18	1.025	18.45	-18.3			163	455.82
3	Bus 3	1	13.8	1.025	14.145	-29.82			85	217.17
4	Bus 4	1	230	0.91276	209.935	-12.8	30	50		
5	Bus 5	1	230	0.82355	189.417	-20.81	125	60		
6	Bus 6	1	230	0.87807	201.957	-23.5	90	30		
7	Bus 7	1	230	0.75364	173.338	-25.88	100	500		
8	Bus 8	1	230	0.77212	177.588	-31.94	100	65		
9	Bus 9	1	230	0.90215	207.495	-32.91	150	60		

Table 4: Record of Bus Data when put SVC on bus no. 9 at that time control bus 4, 6, 9

Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar
1	Bus1	1	16.5	1.04	17.16	0			365.27	217.92
2	Bus 2	1	18	1.025	18.45	-17.54			163	369.62
3	Bus 3	1	13.8	1.02502	14.145	-28.33			85	48.46
4	Bus 4	1	230	0.9413	216.5	-12.41	30	50		
5	Bus 5	1	230	0.86223	198.313	-19.9	125	60		
6	Bus 6	1	230	0.93394	214.807	-22.49	90	30		
7	Bus 7	1	230	0.80578	185.33	-24.62	100	500		
8	Bus 8	1	230	0.84441	194.215	-30.05	100	65		
9	Bus 9	1	230	0.9985	229.655	-31.12	150	60		

Table 5: Record of Bus Data when put SVC on bus no. 8 at that time control bus 4, 6,9,8,7

Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar
1	Bus1	1	16.5	1.04	17.16	0			364.55	127.63
2	Bus 2	1	18	1.02501	18.45	-17.55			163	115.33
3	Bus 3	1	13.8	1.02505	14.146	-25.48			85	-117.78
4	Bus 4	1	230	0.99012	227.727	-11.77	30	50		
5	Bus 5	1	230	0.9476	217.947	-18.68	125	60		
6	Bus 6	1	230	1.0042	230.965	-20.68	90	30		
7	Bus 7	1	230	0.95985	220.765	-23.5	100	500		
8	Bus 8	1	230	1.08638	249.866	-27.92	100	65		
9	Bus 9	1	230	1.09346	251.496	-28.02	150	60		

B. Advantages of SVC

- The main benefit of SVC on mechanically mechanized compensation schemes is the immediate response to the change in system voltage. For this reason, they are often near their zero point to maximize reactive power correction, they can provide fast when necessary.
- They are generally high-power, fast and more reliable than dynamic compensation plans like synchronous condensers.

IX. PERFORMANCE ANALYSIS OF STATIC SYNCHRONOUS COMPENSATOR AS A FACTS DEVICE

Static Synchronous Compensator (STATCOM) is one of the key facts tools. Based on the voltage-source converter, STATCOM regulates the system voltage by absorbing or producing the reactive power. Unlike thyristor-based Static Var Compensator (SVC), the static output current (inductive or capacitive) AC system can be controlled independently from the voltage.
Here we can see STATCOM for the purposes listed below,

- To control the dynamic voltage in the electrical system and distribution system.
- Used for treatment during the power oscillation damping condition.
- The device can also be used to treat the transient stability of the power system.
- STATCOM can be considered a very similar device because it is a synchronous machine. Both have the same tendency to generate 3 phase electrical power with the desired controlled frequency, phase angle and the magnitude of the basic voltage. They can generate reactive power and active power for both systems. But one of the main differences between them is that the STATCOM can provide an electrical power exchange for a short time, but synchronous machines can produce continuously for the given system. Therefore, the utility of the above mentioned STATCOM circuit is shown.

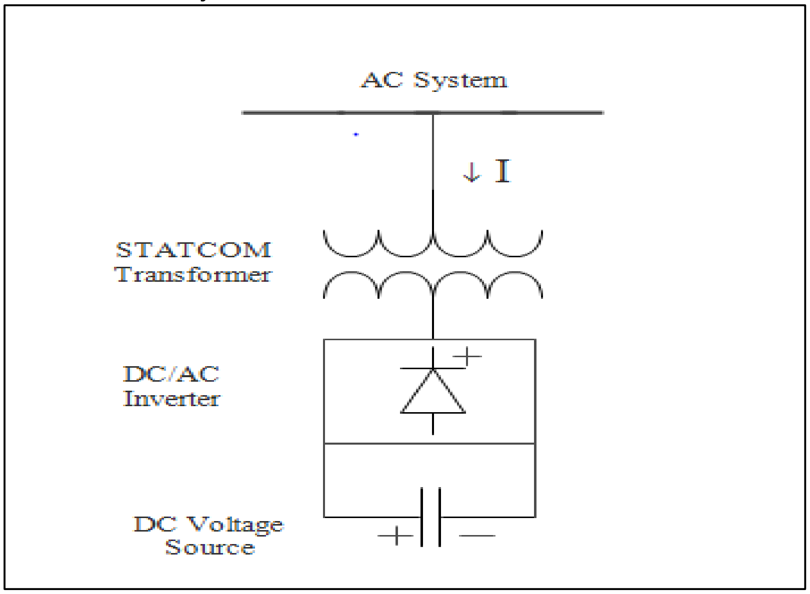


Fig. 15: STATCOM

In the power grid, a transmission line of 600 km is equivalent to 50000 KV (3,000 MVA and 2500 MVA respectively). When STATCOM is not in operation, the "natural" electric current on the transmission line is 930 MW from bus B1 to B3. STATCOM is located on the middle of the line (Bus B2) and it has a rating of +/- 100 MVA. This STATCOM is a pasar model of a normal three-level PWM STATUSM. If you open the STATCOM dialog box and select "Display Power Data", you will see that our model represents the nominal voltage of 40 KV DC link with the STATCOM equivalent capacitor of 375 UF. On one side, its total equal impedance is 0.22 PU at 100 MVA. This impedance represents the transformer leak and the actual PWM STATCOM represents the IJBT Bridge's reactor.

C. Simulation

Now we will verify the dynamic response of our model. Open the STATCOM dialog box and select the "Display Control Parameter" Verify that "Operation Mode" is set to "Voltage Regulation" and "The external control of the reference voltage Vref" is selected. In addition, the "drum" parameter should be set to 0.03 and "Ric Regulator Gains" 5 (Proportional Profit KP) and 1000 (of Integral Profit). Close the STATCOM dialog block and open the "Step Vref" block (the red timer block associated with "Vref" input of STATCOM). This block should be programmed to modify the reference voltage Vref: Initially Vref is set to 1 PU; T = 0.2 S, VRF 0.97 Pu decreased, so, on T = 0.4 S, Vref has increased 1.03; And finally, at 0.6 s, Vref is set back in 1 Pu. Also, make sure that the fault breaker on bus B1 will not work during simulation (parameter "switching phase A, B and C" should not be selected).

Run the simulation and look at the "VQ_STATCOM" scope. The first graph displays the Vref signal (magenta trace) with positive-sequence voltage VM measured in STATCOM bus (Black trace). The second graph shows the reactive power QM (black trace) absorbed (positive value) or generated (negative value) by STATCOM signal Qref (magenta trace) is not relevant to our simulation because STATCOM is in "voltage regulation" and " "Not in.

Looking at the Qm signal, we can determine that the lock-loop time of the system is constant, approximately 20 ms. This time the stability mainly depends on the strength of the power system on bus B2 and the programs of STATCOM depend on Rick

Ricotta benefits. is. To see the effect of regulatory gains, double the two benefits of Rick Regulator benefit and run the simulation again. You should follow a very strong reaction with a little overshoot.

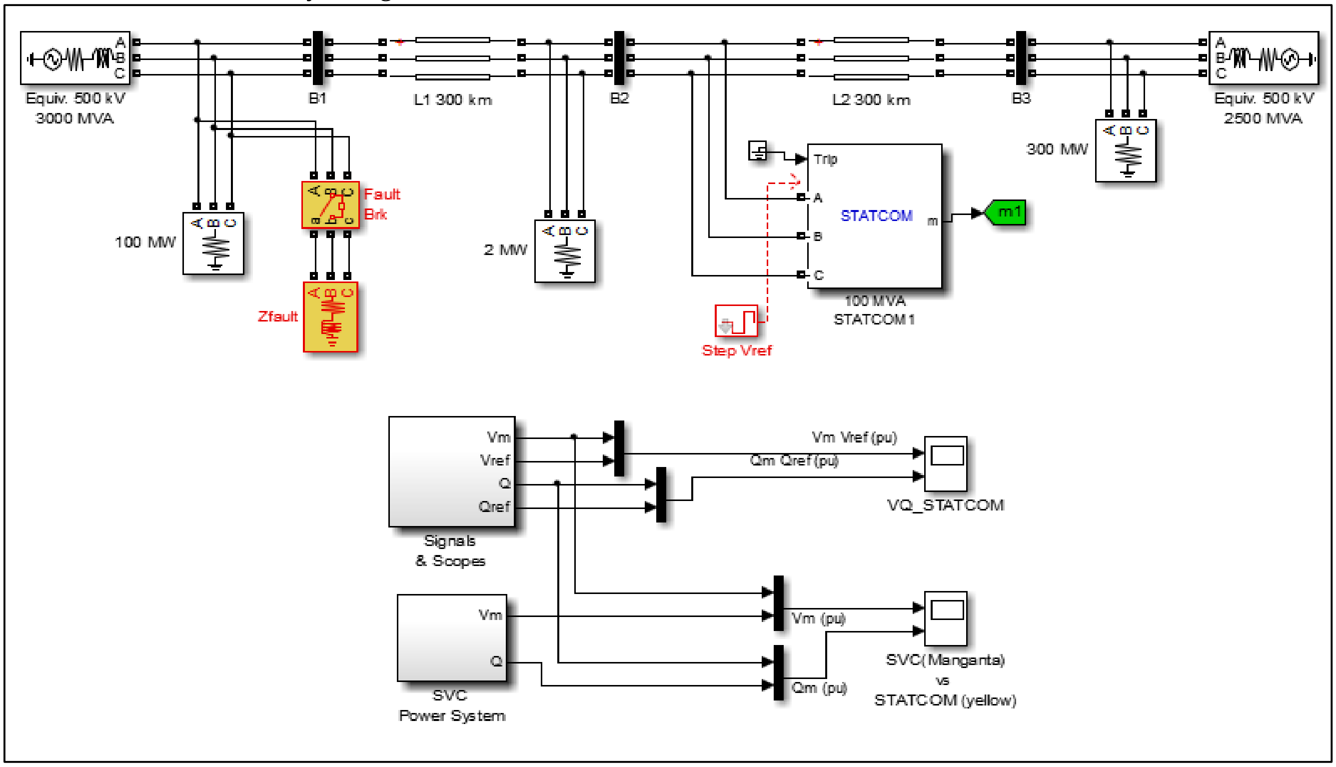


Fig. 16: Static Synchronous Compensator

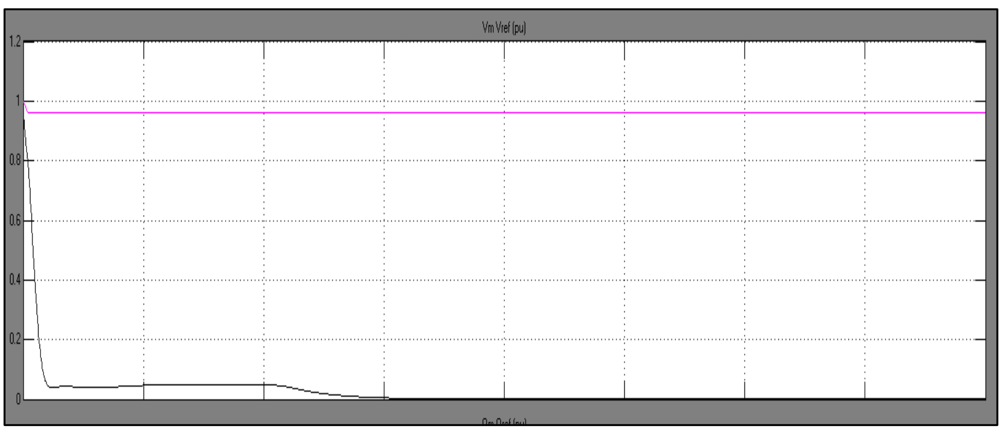


Fig. 17: Graph of va

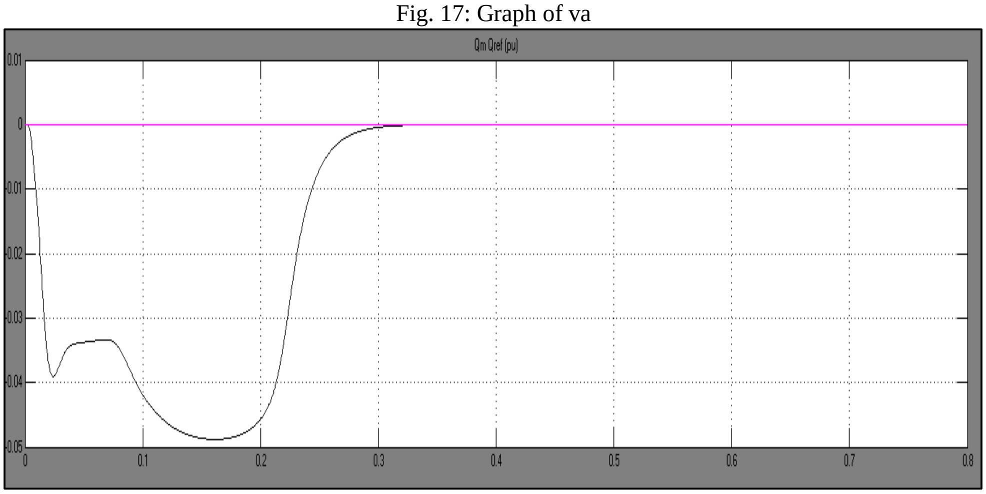


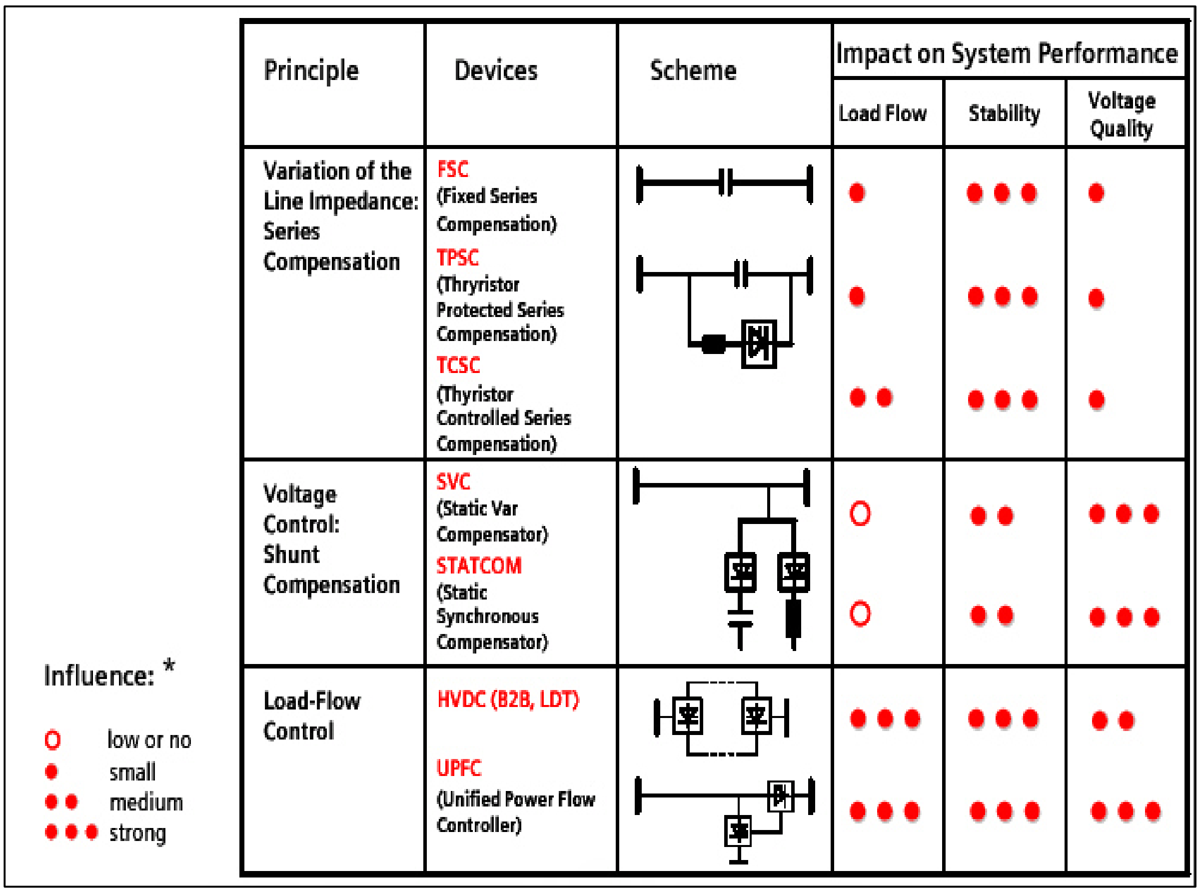
Fig. 18: Graph of vq

Looking at Vm and Vref signals, you can see that STATCOM does not work as a perfect voltage regulator (VM does not exactly follow reference voltage Vref). This is due to the regulator drum of 0.03 PU (controlling the slope). For the maximum capacitive / inductive range given, this tilt is used to increase the linear operational range of STATOCM and also to ensure that automatic load sharing with other voltage compiler (if any) is ensured. Go. Set the inclination parameter to 0 and the voltage regulator provides returns up to 5 (kP) and 1000 (k). If you run the simulation again, you will see that the measured voltage VM now adheres to the reference voltage Vref completely.

X. OBJECTIVES

The main goal is to maintain the voltage profile with the help of facts instruments in the transmission grid.
The underlying objectives are:
- Review the guidelines and rules regarding the tools in the power grid system.
- Study of economic aspects and technical limitations like investment and harmonic resonance.

XI. COMPARISON OF DIFFERENT COMPENSATION DEVICES



Principle	Devices	Scheme	Impact on System Performance: Load Flow	Stability	Voltage Quality
Variation of the Line Impedance: Series Compensation	FSC (Fixed Series Compensation)		●	●●●	●
	TPSC (Thryristor Protected Series Compensation)		●	●●●	●
	TCSC (Thyristor Controlled Series Compensation)		●●	●●●	●
Voltage Control: Shunt Compensation	SVC (Static Var Compensator)		○	●●	●●●
	STATCOM (Static Synchronous Compensator)		○	●●	●●●
Load-Flow Control	HVDC (B2B, LDT)		●●●	●●●	●●
	UPFC (Unified Power Flow Controller)		●●●	●●●	●●●

Influence: *
○ low or no
● small
●● medium
●●● strong

Fig. 18: Comparison Table

XII. CONCLUSION

From all previous discussions, we can eliminate reactive power compensation to improve the performance of the AC system. Our objective, through reactive power compensation, is to control the power factor and reduce power consumption. Capacitor is an option for improving the power factor of the bank network.

From the study of above facts device can be concluded that every device has its own features and all the devices different practical implementation aspects are, depending on their Vi characteristic and application, we can say SVC is better than TSC, TSCS and SSSC.

In this project, the simulation model of static synchronous compensator STATCOM based theorist is built on MATLAB /SIMULINK software. Reactive power output was obtained from charging and energy storage capacitor discharge. The amount of reactive power is based on thyristor-firing angle. Regarding the system voltage, the magnitude of the STATCOM terminal voltage was controlled. The STATCOM model tested on MATLAB /SIMULINK has shown that this voltage can improve sagittal vector (magnitude and duration). In addition, it has shown the rapid response voltage sagging phenomenon of STATCOM. The results of simulations show that the voltage sag improvement proposed by a STATCOM can significantly reduce the number of travel in sensitive devices.

MATLAB/SIMULINK and POWER WORLD environment is used for this comparative study to model and simulate FC-TCR type SVC, STATCOM, connected to a simple transmission line. This project presents performance of all the above FACTS devices and an elaborate comparison between their performances. Power flow and voltage profile are seen to improve with all the compensating devices.

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