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DIFFERENT TYPES OF FACTS DEVICE IN POWER SYSTEM

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ABSTRACT

Modern power systems are prone to widespread failures. With the increase in power demand, operation and planning of large interconnected power system are becoming more and more complex, so power system will become less secure. Operating environment, conventional planning and operating methods can leave power system exposed to instabilities. Voltage instability is one of the phenomena which have result in a major blackout. Moreover, with the fast development of restructuring, the problem of voltage stability has become a major concern in deregulated power systems. To maintain security of such systems, it is desirable to plan suitable measures to improve power system security and increase voltage stability margins. FACTS devices can regulate the active and reactive power control as well as adaptive to voltage magnitude control simultaneously because of their flexibility and fast control characteristics. Placement of these devices in suitable location can lead to control in line flow and maintain bus voltages in desired level and so improve voltage stability margins.

Keywords: FACTS Devices : SVC,TCSC,SSSC,UPFC.

I. INTRODUCTION

MODERN, power systems are prone to widespread failures. With increased loading of existing power transmission systems, operation of power system becomes more complex and power system will become less secure. Operating environment, conventional planning and operating methods can leave systems exposed to instabilities. Voltage instability is one of the phenomena which have result in a major blackout. Besides, with the electricity market deregulation, number of unplanned power exchanges increases due to the competition among utilities and direct contracts concluded between generation companies and costumers. If these exchanges are not controlled, some lines may become overloaded. Because many of the existing transmission lines could not cope with increasing power demand, the problem of voltage stability and voltage collapse has also become a major concern in planning and operation of deregulated power systems. So control of power flow in order to have more efficient, reliable, and secure system is in the interest of the transmission system operator (TSO). To overcome this problem, FACTS devices are introduced. FACTS devices can regulate the active and reactive power control as well as adaptive to voltage magnitude control simultaneously by their fast control characteristics and their continuous compensating capability and so reduce flow of heavily loaded lines and maintain voltages in desired level. Besides, FACTS devices can improve both transient and small signal stability margins. Controlling the power flows in the network, under normal and abnormal conditions of the network, can help to reduce flows in heavily loaded lines, reduce system power loss, and so improve the stability and performance of the system without generation rescheduling or topological changes in the network. Because of the considerable costs of the FACTS devices, it is so mementos to find out the optimal location for placement of these devices to improve voltage stability margins and enhance network security. Effect of FACTS devices on power system security, reliability and loadability has been studied according to proper control objectives.

II. GENERALITIES ON FACTS DEVICES

In a power system, FACTS devices may be used to achieve several goals. In steady-state, for a meshed network, they can permit to operate transmission lines close to their thermal limits and to reduce the loop flows. In this respect, they act by supplying or absorbing reactive power, increasing or reducing voltage and controlling series impedance or phase-angle. Their high-speed command gives them several qualities in dynamic stability. In particular, they are capable to increase synchronizing torque, damp oscillations at various frequencies below the rated frequency (0.2 to 1.5 Hz), support dynamic voltage or control power flows. Moreover, FACTS devices may have benefits in case of short circuits, by limiting short-circuit current . Another advantage of FACTS devices consists in the fact that the technology givestheopportunitytoextendthecurrenttransmission line limits in a step-by-step manner with incremental investment when required. Furthermore, it offers the possibility to move an installation when it becomes not useful anymore. Different types of devices have been developed and there is various ways to class them:

the technology of the used semiconductor,

the possible benefits of the controllers,

the type of compensation.

According to the last classification, we may distinguish three categories of FACTS controllers:

• series controllers

• shunt controllers

• combined series-shunt controllers

Inside a category, several FACTS devices exist and each one has its own proprieties and may be used in specification texts. The choice of the appropriate device is important since it depends on FACTS Devices.

In this paper, four different FACTS devices have been desribe to improve voltage stability margins in power system. These are: TCSC (Thyristor Controlled Series Capacitor), SVC (Static VAR Compensator),SSSC(Static Synchronous Series compensator) and UPFC (Unified Power Flow Controller). These are shown in Fig. 1.

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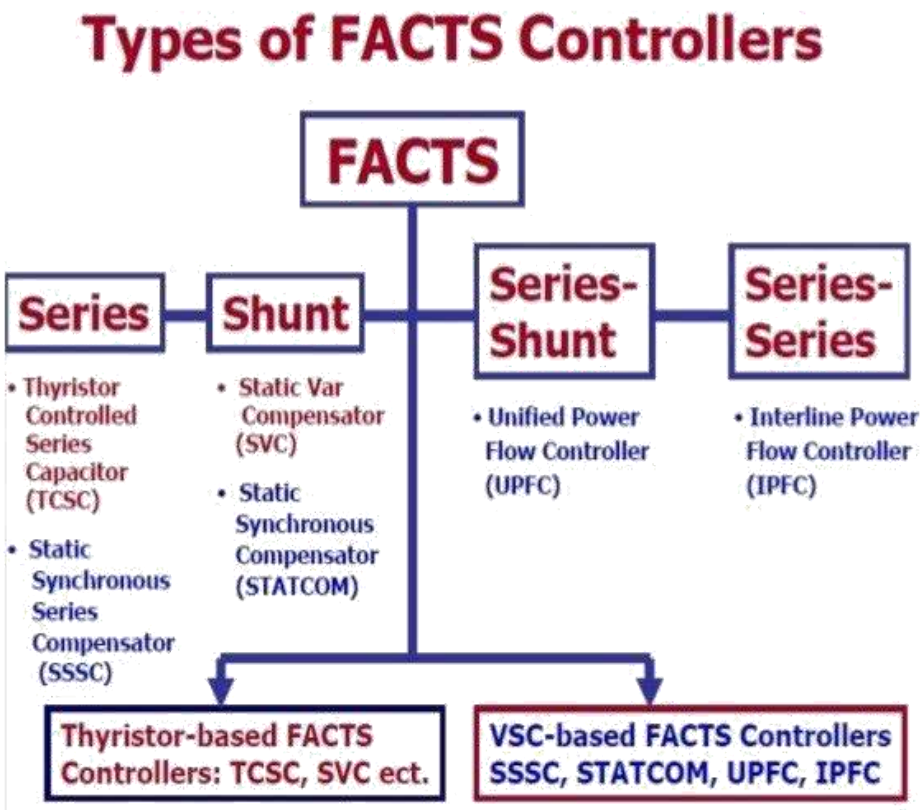

Fig1: types of FACTS Controller

2.1 STATIC VAR COMPONSATOR(SVC)

Static var systems are applied by utilities in transmission applications for several purposes. The primary purpose is usually for rapid control of voltage at weak points in a network. Installations may be at the midpoint of transmission interconnections or at the line ends. Static Var Compensators are shunt connected static generators absorbers whose outputs are varied so as to control voltage of the electric power systems. In its simple form, SVC is connected as Fixed Capacitor-Thyristor Controlled Reactor (FC-TCR) configuration as shown in Fig. 2. The SVC is connected to a coupling transformer that is connected directly to the ac bus whose voltage is to be regulated. The effective reactance of the FC-TCR is varied by firing angle control of the antiparallel thyristors. The firing angle can be controlled through a PI (Proportional + Integral) controller in such a way that the voltage of the bus, where the SVC is connected, is maintained at the reference value.

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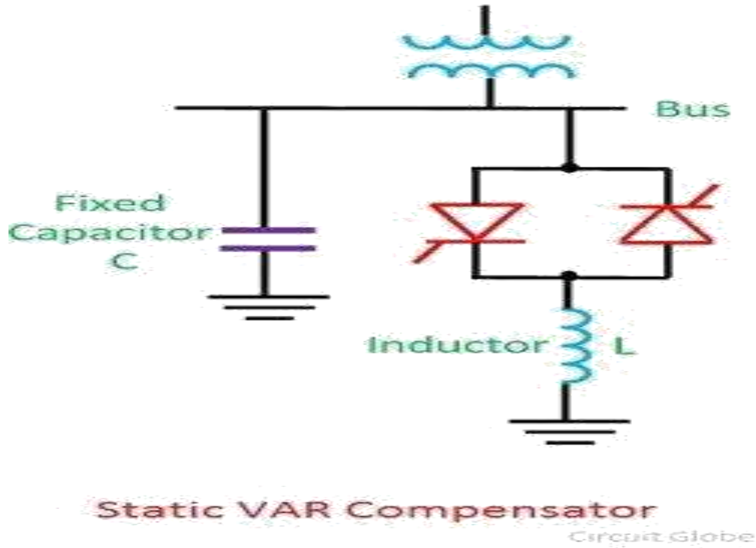

Fig2: Static VAR Compensator

2.2 THYRISTOR CONTROLLER SERIES CAPACITOR(TCSC)

TCSC is one of the most important and best known FACTS devices, which has been in use for manyyears to increase thepower transfer as well as to enhance system stability. The main circuit of a TCSC is shown in Fig. 3. The TCSC consists of three main components: capacitor bank C, bypass inductor L and bidirectional thyristors SCR1 and SCR2. The firing angles of the thyristors are controlled to adjust the TCSC reactance in accordance with a system control algorithm, normally in response to some system parameter variations. According to the variation of the thyristor firing angle or conduction angle, this process can be modeled as a fast switch between corresponding reactances offered to the powersystem.

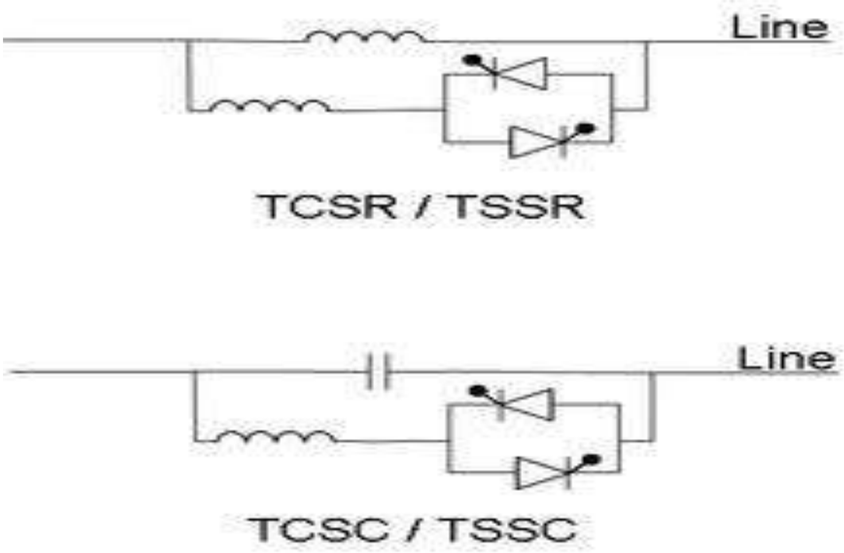

Fig 3: Thyristor Controlled Series Capacitor

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2.3 STATIC SYNCRONOUS SERIES COMPENSATOR(SSSC)

The SSSC is one of the most recent FACTS devices for power transmission series compensation. It can be considered as a synchronous voltage source as it can inject an almost sinusoidal voltage of variable and controllable amplitude and phase angle, in series with a transmission line. The injected voltage is almost in quadrature with the line current. A small part of the injected voltage that is in phase with the line current provides the losses in the inverter. Most of the injected voltage, which is in quadrature with the line current, provides the effect of inserting an inductive or capacitive reactance in series with the transmission line. The variable reactance influences the electric power flow in the transmission line.

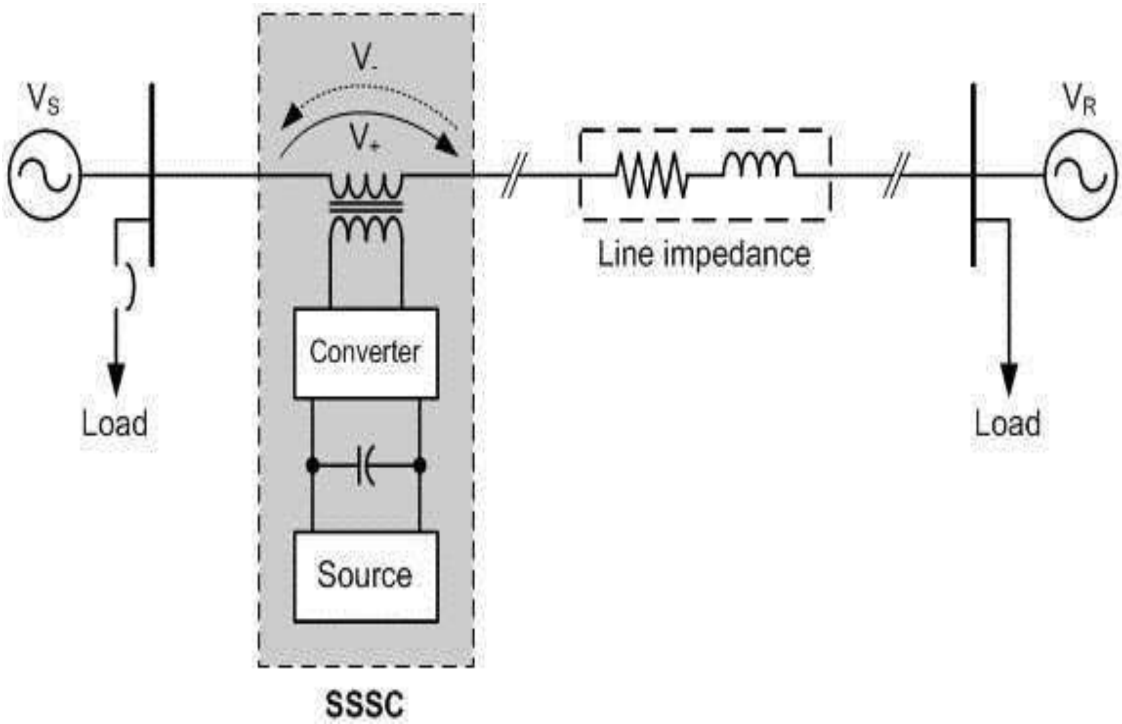

Fig 4: Static Synchronous Series Compensator

2.4 UNIFIED POWER FLOW CONTROLLER (UPFC)

Among the available FACTS devices, the Unified Power Flow Controller (UPFC) is the most versatile one that can be used to enhance steady state stability, dynamic stability and transient stability. The basic configuration of a UPFC is shown in Fig.5.The UPFC is capable of both supplying and absorbing real and reactive power and it consists of two ac/dc converters. One of the two converters is connected in series with the transmission line through a series transformer and the other in parallel with the line through a shunt transformer. The dc side of the two converters is connected through a common capacitor, which provides dc voltage for the converter operation. The power balance between the series and shunt converters is a prerequisite to maintain a constant voltage across the dc capacitor. As the series branch of the UPFC injects a voltage of variable magnitude and phase angle, it can exchange real power with the transmission line and thus improves the power flow capability of the line as well as its transient stability limit. The shunt converter exchanges a current of controllable magnitude and power factor angle with the power system. It is normally controlled to balance the real power absorbed from or injected into the power system by the series converter plus the losses by regulating the dc bus voltage at a desired value.

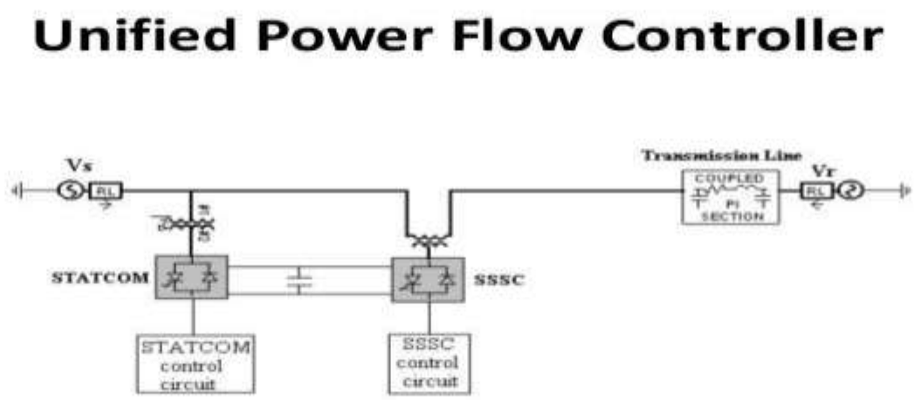

Fig5: Unified Power Flow Controller

TCSC can change line reactance and SVC can be used to control reactive power in network. UPFC is the most versatile member of FACTS devices family and can be applied in order to control all power flow parameters (i.e. line impedance, bus voltage, and phase angle). Power flow can be controlled and optimized by changing power system parameters using FACTS devices.

III. CONCLUSION

We have presentedthe different type of facts devices is used for power flow control ,voltage regulation ,enhancement of transient stability and mitigation of system oscillation.FACTS Controller is a power electronics based system or other static equipment that provides control of one or more AC transmission system parameter. FACTS Devices increase power transfer capability.

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