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Contribution of a Static Var Compensator in the compensation of reactive energy

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Abstract—Maintaining stability and voltage control to an acceptable level still remains a serious problem and requires daily monitoring by managers of grids. To remedy to this, this paper will touch on several solutions. Starting with synchronous machines, as electromechanical devices, that can produce or consume reactive power. Moving to fixed capacitors switched by circuit breakers, ending by FACTS devices that can provide an efficient and reliable solution to deal with this situation. The purpose of this article will focus on the study of the impact of a shunt FACTS device, named SVC “Static Var Compensator” (Var: Volt Ampere Reactive).

Keywords—SVC – FACTS – Compensation – TSC – TCR

I- INTRODUCTION

The fundamental purpose of grids is to provide customers with electrical energy with perfect continuity, in a form of sinusoidal voltage, with pre-established amplitude and frequency values. However, this goal seems ideal, it is never easy to ensure it, as the grid is expected to operate in an increasingly aggressive environment, and as a result, it faces many types of disturbances.[1]

The development of power electronics has a considerable effect on improving the operating conditions of power grids by introducing control devices based on very high power electronics components (GTO, IGBT, ...) known by the acronym FACTS: Flexible Alternative Current Transmission Systems. The technology of these systems ensures a much faster speed than conventional electromechanical systems.[2]

In this paper, there will be a focus on the voltage compensation problem. In[3], to remedy to this problem, a study was done to see the impact of classical devices, such as synchronous machines & fixed capacitors, compared to FACT Systems, especially the Static Var Compensator. Some simulation results are to show how the SVC is able to regulate voltage at a power grid terminal, by controlling the amount of reactive power injected into or absorbed from the electrical system.

II- THE PRINCIPLE & WAYS OF COMPENSATION

The transport of energy for long distances has several disadvantages such as considerable voltage drops, Joule effect and less capacity to carry active power. Currently, with the complexity of networks, the participation of generators in the production of reactive energy has become insufficient.

There are many reactive energy compensation and voltage regulation devices, among which are: Synchronous compensators, fixed capacitors & static compensators.

We will focus on Static Compensators, which are FACTS devices. The FACTS concept is a generic term that characterizes all equipment involving power electronics (diodes, thyristors, GTO, IGBT...). The interest of these systems is not only to be able to control the flow of power in the networks but also to increase the effective transport capacity while maintaining or even improving the stability of the grid.

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Static compensators are three categories: shunt compensators, series compensators & hybrid compensators.

III- STATIC VAR COMPENSATOR : AS A BASIC EXAMPLE OF A SHUNT COMPENSATOR

The Institute of Electrical and Electronics Engineers (IEEE) defines SVC (Static Var Compensator) as a static shunt reactive energy generator (or absorber) whose output is adjusted in capacitive or inductive currents to control specific parameters to the grid, typically the voltage of the nodes.[4]

The SVC is the first generation FACTS that was introduced to the market almost twenty years ago. It consists of a thyristor-switched capacitor bank (TSC) and a thyristor Controlled Reactor (TCR) bank as shown in Figure (1).

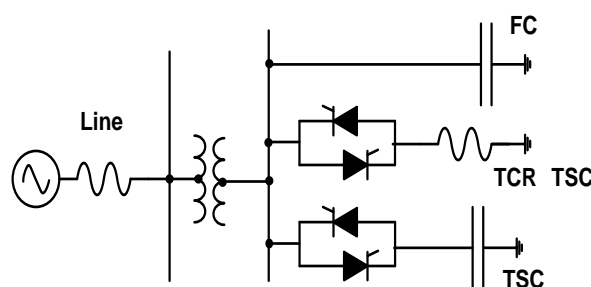


Figure 1: SVC Diagram

The SVC is based on ordinary inductive and capacitive elements, controlled by ordinary thyristors.

The main functions of an SVC are: the voltage support, power oscillations damping & the improvement of static and transient stability margins.

From the static compensator SVC characteristic, three operating zones can be detected:

- A capacitive zone when TSC gives maximum energy, only the capacitors are connected to the grid.
- A mixed or tuning zone or reactive energy is a combination of TCRs and TSCs.
- An inductive zone when the TCR gives its maximum energy (adjustment stop), the capacitors are disconnected.

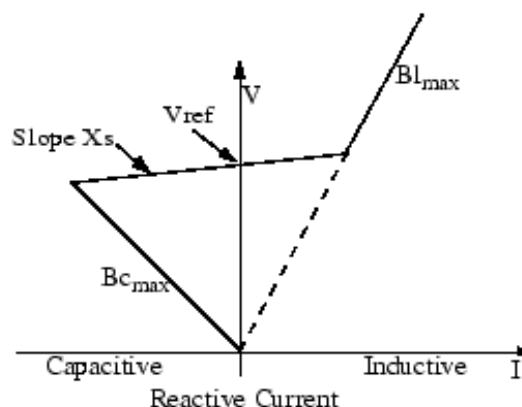


Figure 2: Characteristics Curve of SVC

This type of compensator is widely used for voltage control & regulation[5], especially when the load variation is slow. In addition, the shunt compensator placed in a transmission line gives solutions to the problems of stability.

IV- STATIC VAR COMPENSATOR (SIMULATION & RESULT)

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The use of a grid compensator is in practice very prevalent in voltage support and stability enhancement applications. The simulation model will include a shunt-type Static Var Compensator installed at the end of a transmission line.

The SVC is modeled by a three-wire system using two current sources & it is used to adjust the variation of the grid voltage due to voltage disturbances at the grid level. The voltage source is varying the system voltage, than we observe the SVC performance.

Initially the source is generating its nominal voltage (25 kV). Then, voltage is successively decreased (0.97 pu at $t = 1$ s), increased (1.03 pu at $t = 4$ s) and finally returned to nominal voltage (1 pu at $t = 7$ s).

The figure below shows the actual voltage that goes to the load. During these variations, the SVC current goes from fully capacitive to fully inductive, when the voltage varies from 0.99 pu to 1.015 pu.

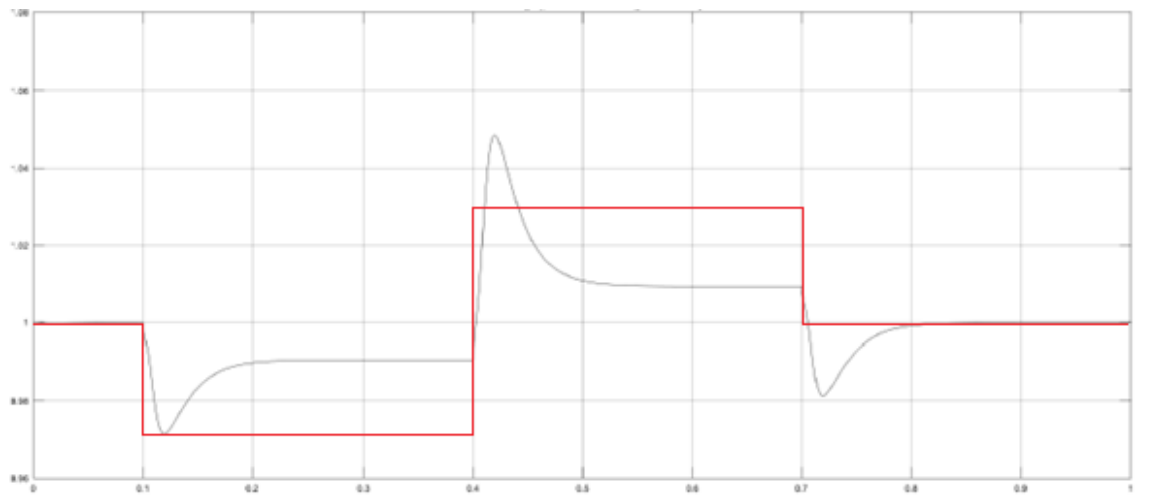


Figure 3: The Voltage at load

We can see from the graphic, the interest of the SVC insertion in a distribution line, and how it is trying to maintain the voltage near from the initial assumption, which is 1pu.

V- CONCLUSION

The SVC serves to absorb the temporary overvoltage that mark weak systems, thus to ensure voltage control. This unit is capable to adjust the reactive power over an unlimited range without any time delay. It improves the system stability and system power factor. However, another FACTS device was developed, with a better performance, high accuracy & fast response time known by the acronym STATCOM: Static Synchronous Compensator.

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