

PSCAD : SVC simulation for transient stability improvement.

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In response to the complexity and the increase of constraints required by the electric networks, fast actuators systems called FACTS have been developed in order to ensure the reliability and flexibility of these networks. One of these compensation devices, a reactive power static compensator (SVC), is studied in this article. This study is carried out through numerical simulations performed with PSCAD/EMTDC software. **It demonstrates the interest of such a simulation tool for teaching and researching.**

Introduction

The speed of devices for power quality improvement (FACTS), which was made possible by the evolution of power electronics components, allows for the solving of problems such as voltage stability, transient improvement, oscillations damping and improvement of the lines performance.

Therefore, their simulation is a great challenge to electrical engineering professionals.

The PSCAD software, that has got such systems in its own library, is particularly efficient in this domain.

This article refers to the simulation of a SVC (STATCOM) device, used to improve the transient stability of a high power electric generator. The results of this case study will emphasize the performances of the device and the capabilities of the software.

SVC Configuration and operating principle

There are several variants of a SVC device. The basic configuration consists in a voltage forced switching convertor, associated to an energy storage component. The configurations depend on the convertor topology (number of levels), the switching control (generally PWM or FFS) and the element of energy storage (a capacitor in the STATCOM model). This device is connected to the high voltage network by means

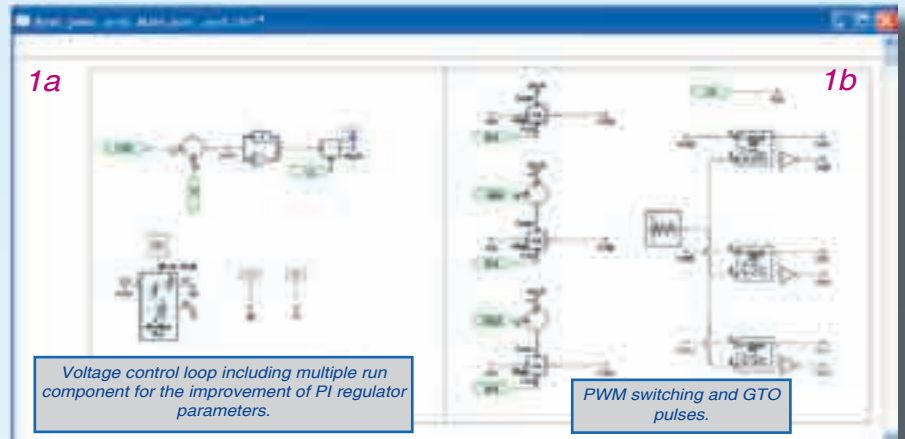


Figure 1a: Regulation loop for the network voltage and parameter optimization of PI regulator.

Figure 1b: PWM under- PSCAD/ EMTDC.

of a step down transformer, so that the network and convertor voltages are in phase. In practice, in order to ensure the necessary energy exchange (active power) between the network and the compensator and to reduce the switching losses of the convertor, these voltages are not in phase. Thus, when the converter voltage leads the network's, the active power is transferred from the compensator towards the network. The capacitor element is discharged and therefore the voltage across the compensator decreases and vice versa.

This phase shift will be used in the control system to allow the power transfer from the compensator towards the network (positive phase shift), in case of over-voltage, and the power transfer from the network towards the compensator, in the case of under-voltage. Such a control system designed by means of this software is shown in figure 1a. Figure 1b shows the implementation of the switches command (PWM).

At the bottom of figure 1a the component named «multiple run» of the library PSCAD/EMTDC is shown. This component is used to optimize the choice of parameters of the PI regulator of the control system. This component allows the user to carry out several simulations by modifying dynamically the values of some parameters (the time constant and

the regulator gain in our case) and to choose the optimal combination of values according to the criterion defined during the configuration (see figure 2).

The component is configured by indicating the number and

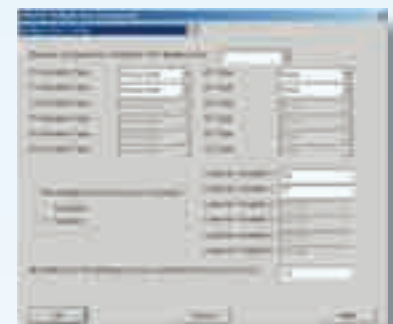


Figure 2a: Multiple-run configuration.

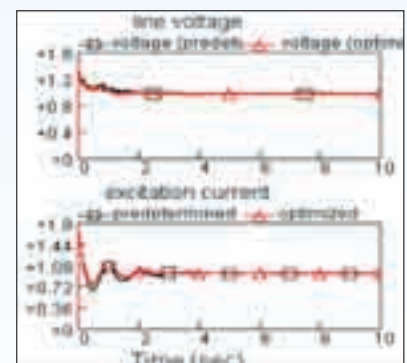


Figure 2b: PI parameters optimisation.

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the variation range of variables to optimize and by defining the selection criterion. Then, the program runs a simulation of all possible combinations of predetermined values and at the end it re-runs the simulation that corresponds to the optimization criterion (in our case this is the minimal error between the controlled voltage and the reference). These values are also saved in a simulation report file.

Application example

In order to illustrate the efficiency of the device and some capabilities of the software, an example has been simulated with PSCAD/EMTDC. The simulated network consists in a generator connected to an infinite power network by means of two interconnection lines in parallel (figure 3). To study the stability of the generator, a three-phases short-circuit close enough to the generator was simulated. To evaluate the effect of the compensation system, the critical time interval of this fault is defined as the maximum time interval of a short-circuit that can be supported by the generator without losing the synchronism if there is no compensator. Then, the compensator is connected to the network in order to see its effect on the value of this critical time interval.

Simulation results

For a three-phases short-circuit that appeared after 10 seconds from the simulation start time, the critical time interval for the simulated case was 478 ms. Several compensation STATCOM devices of different power levels have been simulated and the use of a STATCOM of 250 MVA allowed for an improvement of the critical

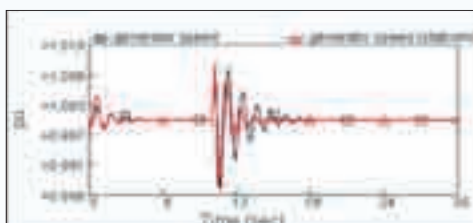


Figure 4: Generator speed with and without STATCOM.

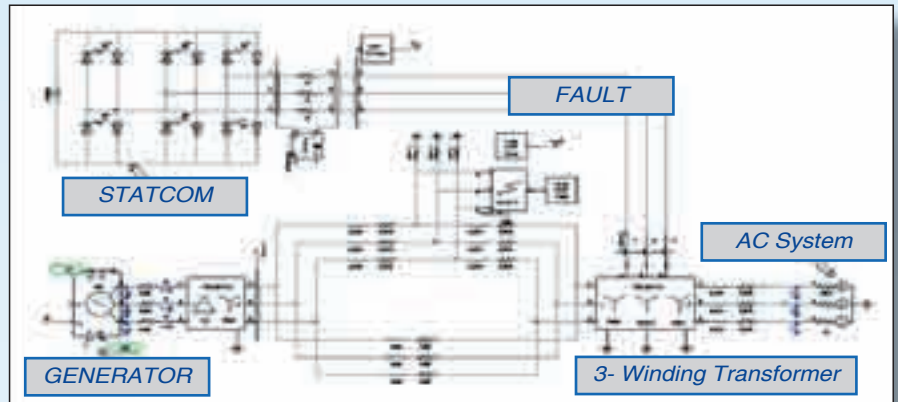


Figure 3: Network modelled with PSCAD/EMTDC.

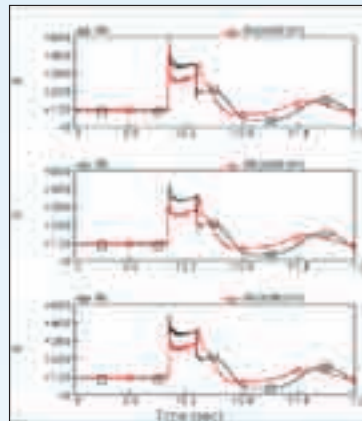


Figure 5: Interconnection line-current.

time interval of about 90 ms (figure 6).

Figure 4 shows a comparison between the speed of the generator with and without the STATCOM compensator and it demonstrates the speed of this compensation device. Figure 5 shows the currents of the interconnection line with and without the compensator. This figure also illustrates the importance of the STATCOM operation. It can be noticed that the current peaks in the fault moment are very high and they can be dangerous for some components of the network, especially for the protection elements. The presence of STATCOM reduces these values to a large extent.

Conclusion

A reactive power static compensator for the improvement of the high voltage network stability has been simulated and its effectiveness

has been illustrated by means of the PSCAD/EMTDC software. Due to the elements available in its library, and to its graphical interface, which facilitates the software understanding, this software is a tool enabling to manage and access new and complex technologies in different domains. Its possible coupling with Matlab/Simulink gives it high power for scientific computation, and other functions related to the treatment, presentation and results post-processing.

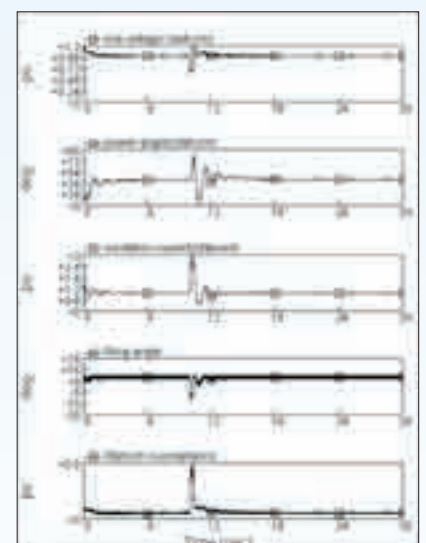


Figure 6: Simulation parameters, maximal critical time interval (566ms).



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