

STATCOM Control Research and Analysis

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Abstract—Through the Introduction of presentation structure and basic functions of a static synchronous compensator (STATCOM) controller, analysis of Reactive Power Compensation Control Method is introduced as an example for inhibit voltage flicker, oscillation damping system ,excellent dynamic qualities of power system normal state transition process and the improvement of power system transient, static stability limit. Advantages and disadvantages of various methods are summed up and the future trends of the prospects are proposed in the last.

Keywords—Static Synchronous Compensator (STATCOM), Current Control, Multi-level Inverter Control, Fuzzy Logic

I . INTRODUCTION

With the development of high-power power electronic devices and Flexible AC Transmission System (FACTS) technology was referred to, FACTS devices in power system development and its application by the increasingly widespread attention. As an important member of FACTS family that one of the static synchronous compensator (STATCOM), also known as Advanced Static Var Generator (ASVG), can be from the entire range of inductive to capacitive reactive power in the continuous adjustment, particularly in underdeveloped Pressure can still be validly issued under the conditions of reactive power, the power industry has been more and more attention.

Well is it known that STATCOM is by self-phase bridge circuit for a direct parallel to the electric line or through the reactor in parallel to the electricity grid. STATCOM under the DC side capacitance or inductance using two different energy storage devices can be divided into Voltage type and current type two kinds. But whether it is voltage or current type STATCOM, the dynamic compensation mechanism is the same. When the inverter pulse width modulation ratio constant, the inverter output phase voltage regulator and the system phase angle between voltage so that we can adjust the reactive power and the DC capacitor voltage inverter; while regulating control angle and the inverter Pulse width modulation ratio, you can maintain the capacitor voltage constant circumstances, the required reactive power was issued or absorbed by STATCOM. According to this principle, developed in Japan from 1980 to the first 20Mvar of forced self-commutation of the bridge STATCOM later,

after a decade of development, STATCOM capacity is increasing, and there have also begun developing out 80Mvar and 100Mvar the STATCOM in Japan and the United States in 1991 and 1995. The summer of 1999, ± 20 Mvar generator power grid trial run in Henan Province^[1]. STATCOM can be seen an important member in the dynamic adjustment of reactive power and voltage. STATCOM is a complex nonlinear strong coupling system, control complexity, however, STATCOM device control system is one of the core in the STATCOM device, which produces and controls a drive through the switching device to control the pulse unit operation, only if they meet control speed, high-precision control of pulse, multi-function and multi-objective control of the request, in order to more fully play its characteristics, the completion of STATCOM devices need to complete the tasks.

II . THE STRUCTURE AND BASIC FUNCTIONS OF STATCOM'S CONTROLLER^[2]

A. *Figure One is the control system of STATCOM installation (± 20 M var) diagram[3] developed by Tsinghua University. The control system has the following components:*

1) *The part of A / D sampling and conversion :*

It mainly gathers system voltage, current of STATCOM and other required voltage and current signals.

2) *The part of data processing and control calculation:*

System voltage, STATCOM device output power, current are calculated based on collected signal. Then the control volume such as the δ angle and θ angle of STATCOM devices is calculated based on these data according to control algorithms .(If you do not control the STATCOM DC-voltage device, β is fixed value and $\theta = \pi - 2\beta$, representing switching device conduction angle. So θ is often used in the future.) Because of the demands of data processing speed, DSP digital signal processing chip is often used as the core components of the STATCOM device controller for dealing with data and control algorithms.

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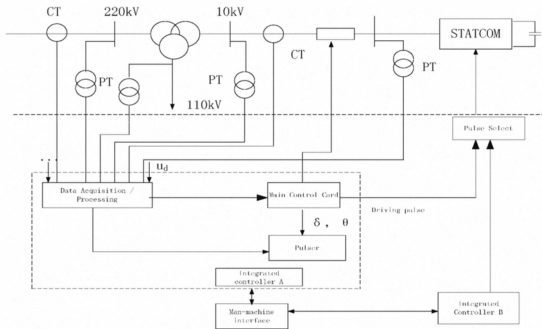


Figure 1: Control System Schematic of $\pm 20M$ var STATCOM device

(3) *Pulse section:*

Strictly synchronous with the system voltage of the driving pulse is obtained for control the switching of STATCOM device switching devices based on system synchronization signal and control calculation part of the given control angle.

B. *STATCOM device control system ($\pm 20M$ var) mainly have the following features [4]:*

1) *Product driving pulses*

It produces a certain regular touch pulse enlarged by the gate drive circuit to control the turn on and off of GTO, so that STATCOM device can produce the correct output voltage.

2) *Pulse Synchronization*

According to the synchronization pulses from the power grid to recover, the synchronized with the grid voltage pulse signal can be obtained So that STATCOM device creates a voltage synchronized with the grid voltage for reliable grid operation.

3) *Control the operation of STATCOM device*

In accordance with the requirements of control objectives and control the output voltage and grid voltage phase angle difference δ of STATCOM devices, which can accurately control the STATCOM reactive power output device. If necessary, it can control the GTO's turn-on angle θ ($\theta = \pi - 2\beta$ was known as the GTO's turn-on angle), thereby control the DC side capacitor voltage to ensure the safety of the GTO voltage within the scope of work.

4) *Upper protection function*

As the general control system can be completely STATCOM device current therefore it must have a protective function, namely, the protection STATCOM device can't pass current. STATCOM control system protection features to enable a high level of protection, when the STATCOM devices running on overload or other abnormal conditions, while the current action has not exceeded the protection setting value, the control system should be through the protection feature allows STATCOM device back to normal working state, avoiding the bottom of STATCOM device protection action, so that STATCOM device that can continuously work.

5) *The control system has self-fault-tolerant features*

Once the error in some components, such as the voltage transformer disconnected, the control system should be able to immediately detect and alarm at the same time not to run out of STATCOM devices, failure can be quickly restored after the repair.

6) *Operation is simple and reliable, easy field use*

In response to these STATCOM device structure and function, it is increasingly using a different control method to achieve the multi-objectives and requirements of STATCOM controller.

III. COMPARATIVE ANALYSIS OF SEVERAL CONTROL METHODS OF STATCOM DEVICES

The power system controller design have three difficulties in technical: First, the power system is a big strong nonlinear system. Provinces of modern interconnect power grid coverage area, or even multinational, large capacity, multi-units is a typical large-scale systems. Secondly, the power system is a variable structure, variable parameters of large-scale systems. Due to power system is frequent short-circuit or other fault which led to parameter changes, and thus the power system also is a variable parameter system. This local parameter changes so that a fixed parameter design of local controllers after parameter changes, the control performance becomes poor. Finally, the power system control requirement on the target is a multi-objective. On the one hand users require a higher power quality, on the other hand, the power system but also ensure its own security, so the requirements of the power system controller must be multi-objective, while the STATCOM is to maintain power system voltage stability and reactive power compensation important devices, so the power system to STATCOM controller, multi-objective requirement is even more important, its objectives are mainly the following points.

- Maintain STATCOM connecting point with the system voltage is basically unchanged, inhibit voltage flicker.
- The damping system oscillation.
- So that the power system has a good dynamic quality from a normal state to another normal state transition.
- To improve power system transient stability limit.
- To improve power system static stability limit. STATCOM has two main purposes: power factor correction system and regulating the system voltage. While these two functions are passed the system to inject reactive current to achieve, but for different purposes, control strategies are not the same in totally.

A. *Direct current control and indirect current control^[5-8]*

1) *Direct Current Control*

So-called direct-current control is used to track based on the current waveform PWM control techniques for the instantaneous value of feedback control, direct instructions to the current place. Figure 2 shows the decomposition of the pq the introduction of the direct current control methods. In

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