

The Influences of Fast Switching Series Compensation for Distance Protection

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Abstract. This paper describes the technical principles of series compensation, and introduces the series compensation device structure, and finally got through simulation effects of rapid switching Series Compensation for distribution network distance protection. Distribution network is an important network connections and power grid users, from the distribution of electric energy in the power system, the strength of its transmission capacity directly determines the power user power quality is good or bad. However, since the electricity distribution network of long-term failure to get the attention of practitioners, its construction and the relatively slow pace of reconstruction, the aging serious, increasingly unable to meet the annual growth of electricity demand. The main problem with the presence of the grid are: Distribution network construction is lagging behind, power transmission grid capacity is insufficient. Network structure is irrational, power supply radius is too long, circuitous route power line terminal voltage is too low. Part serious aging distribution equipment and lines, the line number is small, backward technology, serious power loss. Reactive power shortage, power grid is not economical and low power quality. Therefore, how to improve the status of the distribution network has become the focus of power workers

1 Value of series compensation and compensation principle

1.1 Value of series compensation

By capacitive reactance series compensation to offset the line inductance, reducing the electrical distance between the power source and the load point, can solve a series of problems exist in the distribution network, its value lies in:

- 1) solve the supply radius distribution network end of the line is too long due to excessive voltage offset problems and improve power quality.
- 2) to solve the problem of heavy loss of distribution network and improve the economics of grid operation.
- 3) increase the transmission capacity of the line to avoid the reconstruction of the line [1-8].

1.2 Series technical principle of compensation Action series line voltage compensation to improve:

AC line, due to the presence of line resistance and reactance, in power through the load, will produce a voltage drop, the voltage is reduced. Series capacitor compensated by the capacitive reactance to counteract the line inductance reduces the voltage drop across the load current line reactance enhance the line voltage and

reduces the phase angle difference between the terminal voltage line first.

Series compensation for reducing line loss effect:

When the load current flows through the transmission line will produce power loss on line resistance proportional to the square of its size and the current value. Since the series compensation capacitor of access, so that the line voltage increases, at constant load power load current is reduced, thereby reducing the power loss generated on the line.

Series Compensation for improving the transmission capacity of the line:

Limit the power line transmission power and line reactance inversely, if we can reduce the line reactance, it is possible to improve the stability limit and transmission power lines. Series compensation is used to compensate for line reactance, thereby enhancing the transmission capacity of the line [9-12].

2 Series compensation structure introduction

2.1 General structure type Series Compensation

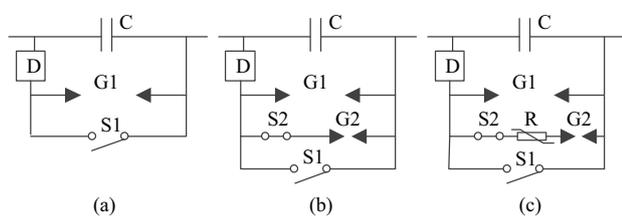
Conventional Series Compensation Series Compensation based on the type of protection can be divided into the main spark gap series compensation devices and metal zinc oxide voltage limiter type (referred to as MOV type)

Series Compensation [13].

2.1.1 FSC spark gap device configuration Introduction

Early FSC bypassed by a spark gap device and bypass breaker components. When a short circuit fault line, the fault current to the rapid increase in the terminal voltage of the capacitor. When the spark gap felt transient voltage exceeds the trigger value, the gap flashover bypass capacitor. Since the spark gap does not have the ability to self-extinguish the arc prepared, so that by closing the bypass switch interrupter. After troubleshooting, bypass switches gate, series capacitor running again.

In order to fill the gap as a string through the main protection voltage capacitors, specifically divided into single space, double space and SIC nonlinear resistance band gap protection mode, the typical configuration is shown in Fig. 2.1.

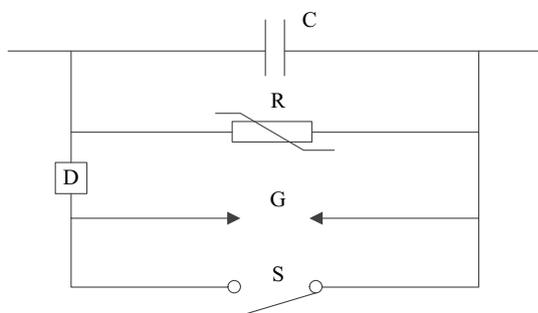


C—Capacitor banks D—Damping circuit R—SIC resistance
 G1,G2—Spark gap S1,S2—Bypass Switch

Figure 2.1. Series Compensation spark gap.

For the gap compensation means in series, due to the instability of its action, after maintenance difficulties, short-circuit failure bypass and re-invest their time to reach 200 ~ 400ms, resulting in a greater impact on the protection line. And because of the complex structure of the spark gap, make huge volume series compensation means expensive.

2.1.2 Metal oxide type series compensation voltage limiter device configuration Introduction



C—Capacitor banks D—Damping circuit R—ZnO resistance
 G—Spark gap S—Bypass Switch

Figure 2.2. Metal oxide type voltage limiter Series Compensation.

Currently series compensation devices typically use their equipment from a metal oxide zinc bypass voltage limiter

(MOV) and trigger gap composition, MOV as the main capacitor overvoltage protection, trigger gap as the backup protection MOV, which arrangement method shown in Fig. 2. 2.

MOV as the main protection series compensation capacitor bank, under steady state conditions showed a high impedance characteristics, the equivalent of an open state, then the capacitor in series with the circuit [14]. When a fault occurs after the capacitor voltage reaches its tolerance limit, MOV conduction bypass capacitor bank. After the fault is cleared, the capacitor back into operation.

2.1.3 Fast switching series compensation device configuration Introduction

Conventional series compensation device, because of the configuration of complex, bulky, expensive, input and output is relatively low, the device's own security, reliability and poor range of issues in high voltage distribution network has not been widely used.

Clearance is the application of rapid vacuum switch in the bypass device based on the fast switching series compensation device replace the spark that once the wiring diagram is shown below.

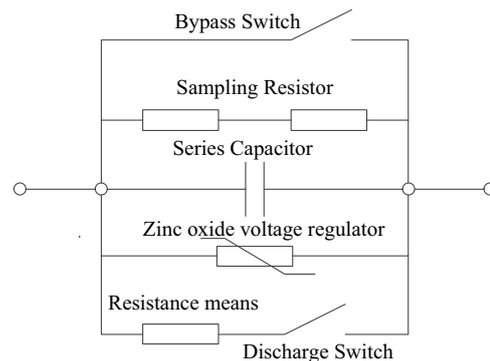


Figure 2.3. Fast switching Series Compensation Schematic.

Fast switching series compensation means each part of the main features:

- 1) Series capacitor banks: to compensate for line drop, improve voltage quality. According to the requirements of the rational allocation of capacitor compensation depth, the normal operation of the capacitor in series with the circuit;
- 2) Zinc oxide components: series compensation for limiting the voltage across the capacitor. Zinc oxide valve series and parallel composition, zinc oxide series voltage lower than the threshold voltage of the capacitor power lines during normal operation, zinc oxide does not move; when external short circuit, the voltage across the capacitor is limited to a low level, to protect the capacitors are not damaged;
- 3) The rapid vacuum discharge switch: for rapid release of the charge storage capacitor in series eddy current drive technology based on rapid development rapid vacuum circuit breakers. Normal operation Fast switching device is in the open state, for turning the capacitor discharge circuit when the line is short-circuited

[15]. Its closing time can be controlled at about 10ms, opening time can be controlled within 5ms. Rapid vacuum circuit breakers, combined with the short-circuited rapid identification technology to achieve a short-circuit in the wiring to series capacitors rapid short about 15ms, greatly shortening the duration of the over-voltage, so that the zinc oxide component It can greatly reduce the required capacity. Reduces capacitor operating safety protection and the zinc oxide component can capacity for research and development of series compensation device technical basis;

4) Discharge damper device: to limit the discharge current of the capacitor, the parallel discharge by the discharge resistor and an inductor formed. The discharge current is limited to within the permissible range, to prevent the occurrence of the discharge switch contact welding;

5) Sampling resistor: capacitor for detecting the operating state and provide electrical quantities to the device control unit to control fast switching and bypass switches open and close [16].

Fast switching series compensation capacitor protection device of its higher reliability, the device smaller and more affordable cost, so that the distribution network series compensation application possible.

3 Impact on the distribution network from the protection of fast switching type Series Compensation

Series capacitors added, undermines the ratio between the line impedance and measure the distance between the impedance of the mutation will take place before and after the series capacitors installed position so that protection can not correctly measure the fault distance, the impact on the distance protection [17].

Theoretical studies show that if can instantly bypass capacitor series compensated quickly, it is possible to weaken the influence of the capacitors on the line after a short circuit fault protection occurs [18]. In recent fast switching series compensation appears a good solution to the problem of bypass capacitors, the following simulation study by the fast switching type Series Compensation Capacitor to Distance Protection.

In this paper, 110kV radial distribution systems for the simulation object, failure time is set to 0.1 seconds, according to the operating characteristics of the fast start time is set after the bypass capacitor short circuit occurs 15ms. Series compensated line system wiring diagram is as follows:

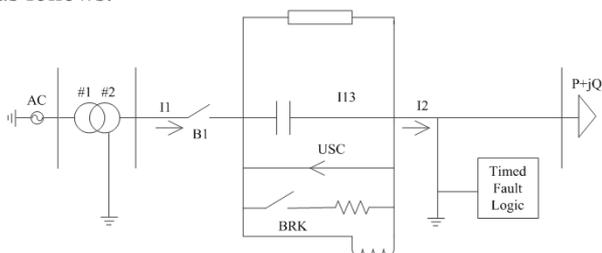


Figure 3.1. Series compensated line system wiring diagram.

Protection segment I Modeling and Simulation
 Fault point is located within the protective action zone

protection installation at the nearby

Series compensation device is mounted to the head-end line, series compensation capacitor circuit protective device side most likely to cause a short circuit fault repellent action, therefore, choose this as the point of failure, tested in the worst case, whether it will protect the series capacitor Impact [19]. A phase short circuit to ground fault, for example, the simulation results are as Fig. 3.2.

The simulation results show that when the series compensation device is mounted in the first end of the line, when the single-phase short-circuit ground fault circuit protection are not subject to influence fast switching series compensation device occurs Series Capacitor line side, can accurately reflect the type of fault and action. Similarly available in any type of fault, fast switching series compensation did not affect the line protection [20-23].

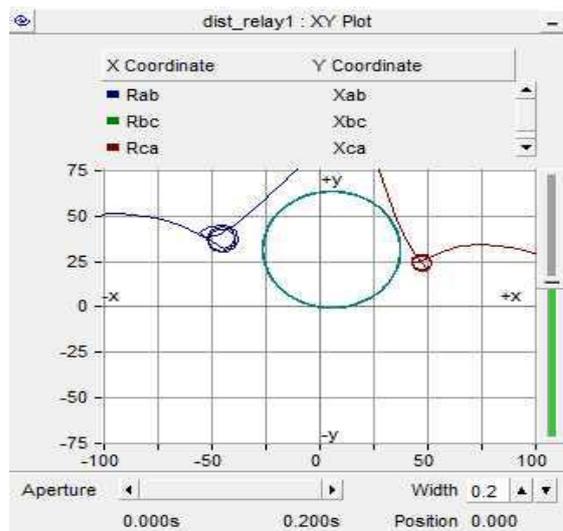
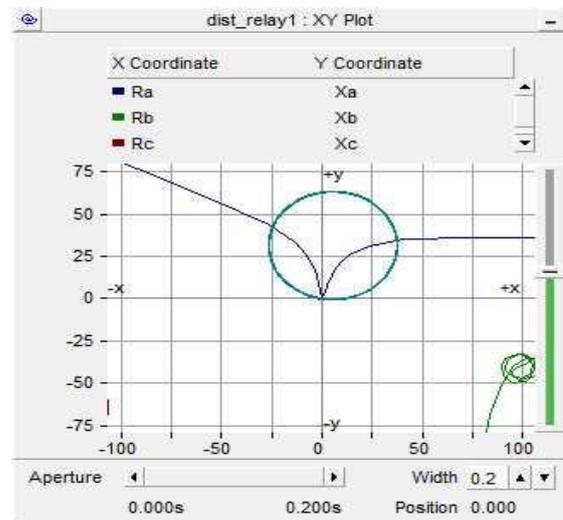


Figure 3.2. Line protection measure impedance trajectory A phase to ground fault occurs.

4 Conclusion

Due to limited space, this is no longer on the installation location and other types of capacitor protection

simulation done carefully explained, only the simulation results are listed below:

Protection I segment:

1) The fault is located within the protective action zone to protect the installation place

Conclusion: no effect;

2) fault point is located outside the protective action zone

Located at the end of the fault line of this paragraph

Conclusion: Protection segment I protection extended to the distance of the line length;

Fault line located adjacent the first end of the series compensation capacitor series compensated line side

Conclusion: the degree of compensation and load carried on this line, but is usually not affected;

Protection II section:

1) located in the lower line fault protection stage O operation outside the area

Conclusion: no effect, the line segment of the section II grade trip protection does not occur;

2) The end of the line fault point is located in this paragraph

Conclusion: no effect, protecting II section to protect this segment line length

Protection III segment:

Conclusion: no effect

In this paper, the impact of series compensation on power relay to conduct a comprehensive study, and fast switching series compensated for the impact of the distribution network from the protection of the simulation experiments, the research has achieved initial results. Limited space, the article did not compensate for a series of low-voltage distribution grid current protection impact do in-depth research, this part of the work remains to be further in the future to perfect.

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