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Power Swing Protection of Series Compensated Transmission Line with Fault Detection Classification and Location

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ABSTRACT

There is a significant difference in fault detection technique of series compensated transmission line during normal operating condition and power swing condition due to several reasons like frequency modulation, sub-harmonic oscillations, transients etc. Especially during power swing condition the frequency of power change is modulated and it is twice of frequency of voltage change and current change. So, cycle to cycle or sample to sample comparison is not reliable here. Other techniques like Voltage Change, Current Change or Impedance change methods are also not applicable during power swing condition. Further inclusion of capacitor in transmission line evokes transients and sub-synchronous resonance activity in series compensated line. So, fault detection during power swing. condition in case of series compensated line is extreme difficult. In this project a method is developed to detect fault of series compensated transmission line during power swing condition. Further the study carried out to identify the proper location and Classification and estimated zone of the fault. Then the study is carried on to identify the exact phase of the fault and how to improve the accuracy of the obtained results by using different types of low pass filter. Each study is carried out on a SMIB and a WSCC-3- Machine-9 bus system with different contingency combinations and by varying different Parameters of the system and the result are listed. The results are available in terms of graphs, figures and tables. Here it proposes a negative-sequence current based technique for detecting presence of fault, classification of fault occurred, estimated zone and location of the fault occurred and the fault inception time with respect to system reference clock during the power swing condition in a series compensated line. In proposed work negative sequence current was analysed as it keeps

the other parameters in the system in healthy state. The proposed approach is a cumulative sum (CUSUM) of change in the magnitude of the negative-sequence current-based approach. The task of series compensation is to reduce the transmission lines inductivity. Means, the line length is virtually shortened.

INTRODUCTION

Fault detection during power swing condition is a challenge for stable operation of power system due to several reasons like protection problems, Voltage/current inversion, sub-harmonic oscillations and transients especially if it is series compensated modulation of voltage and current waveforms with swing frequency etc. Here it proposes a negative-sequence current–based technique for detecting presence of fault, classification of fault occurred, estimated zone and location of the fault occurred and the fault inception time with respect to system reference clock during the power swing condition in a series compensated line. In proposed work negative sequence current was analysed as it keeps the other parameters in the

system in healthy state. The technique is tested for different series-compensated power systems including a SMIB system and a WSCC-9bus-3machine power system with their different configurations and contingency combinations. Power swing caused by various faults are simulated with PSCAD / EMTDC and MATLAB/SIMULINK and compared with available techniques to prove the effectiveness of the proposed technique algorithm.

Fast and accurate determination of a fault in electrical power system is a vital part in power restoration. Power Swing is caused by large disturbances in power system, which if not blocked caused mal-operation of distance relays and undesired tripping of breakers, change in load impedance, unwanted relay operations at different locations of the network, major power-outages or even power blackout. If a fault occurs during the power swing, the relay must detect the fault and operate quickly. The detection of faults in a series-compensated line during power swings is more challenging due to different frequency components in the fault signals which depend on the fault location, type, level of compensation etc cause the apparent impedance seen by the relay to oscillate and imposes difficulty to distinguish faults from the power swing. It proposes a technique for detecting faults in a series-compensated line during the power swing. During unbalanced faults, the negative-sequence components become significant and due to transients in current signals in the initial period, a negative sequence component is present even in three-phase faults. To detect the faults during swing in a series-compensated line, a cumulative sum (CUSUM) of change in the magnitude of the negative-sequence current-based approach is proposed in this paper. The performance is tested for numerous cases for an SMIB system and a 9-bus system simulated with SIMULINK/PSCAD.

OBJECTIVE OF THE WORK

There is a lot of difference in conditions between normal operating condition and power swing condition. Hence fault detection and identification is also different in this two conditions. Specially during power swing condition the frequency of power change is modulated and it is twice of frequency of voltage change and current change. So, cycle to cyclc or sample to sample comparison is not reliable here. Other techniques like Voltage Change, Current Change or Impedance change methods are also not applicable during power swing condition. Further inclusion of capacitor in transmission line evokes transients and sub-synchronous resonance activity in series compensated line. So, fault detection during power swing condition in case of series compensated line is extreme difficult.

The objective of the thesis is to develop a technique which can detect the fault during power swing condition of a series compensated transmission line eliminating all the drawbacks. Later we discussed some more special things like detection of classification and location of the fault, faulty phase Identification etc. After that we have discussed how we can increase the accuracy in the obtained result

SIMULATION RESULTS:

As long as the voltage across the capacitor is above the protective level,the current is flowing into the MOV and the capacitor current is null,when the voltage passes below the protective level,the MOV offers a high resistance and the current,starts flowing into the capacitor again.In any half of current first the capacitor conducts and then the current is switched to the MOV for the rest of the half cycle.The current through the MOV in the unfaulted line is very small compared to that of the faulted phases[3].

CONCLUSION OF MOV :

The main results regarding MOV protected series compensation, obtained by the fault simulation are summarized as follows:

During a three phase fault, the MOV protection devices operate immediately, in order to remove the capacitor banks from the system. However, the capacitor is not isolated from the line, so its reinsertion is instantaneous. An important result is that as soon as the bypass switch closes the line current is reduced to a value, as if there were no capacitor banks in the system. During single phase fault, only protection equipment of faulted phase function, while the capacitor banks of the other phases remain in the system to maintain stability[3].

Also, the MOVs‟ absorption of energy is measured in all phases and the energy is exchanged

between the capacitor and the MOV.

CONCLUSIONS

Series capacitors (SCs) are installed on long Transmission lines to reduce the inductive reactance of the lines[23]. SCs and their associated over-voltage protection devices like metal oxide visitors, and/or air gaps creates several problems for distance relays and fault locators due to harmonic present in actuating quantities, errors in measurement leads to maloperation of distance relay. This can be eliminated by using LPF or certain combinations of LPFs. In this chapter, using sampling of voltage and current waveforms and concepts of sequence network models of different faults, a simple and accurate fault location algorithm is presented for series compensated transmission lines ,later tried to enhance the accuracy with different combinations of RC filters. The power system is simulated using PSCAD/SIMULINK to provide fault data. It is found that with the increase of the stages of RC filter the accuracy can be increased provided the time delay required for operation is kept adjusted.

Series capacitors (SCs) are used to improve the problem of stability, increase power transmission capability and improve voltage control problem of EHV transmission systems. On the other hand, application of these series compensation devices could

result in various problems for transmission line protective systems, e.g. distance relays and fault locators . In a typical series compensation arrangement, the Metal Oxide Varistor (MOV) which protects the capacitor from over-voltages, acts nonlinearly during faults and increases the complexity of the fault location and protection problems.
Difficulties caused by the sudden removal and insertion of capacitors into the circuit are voltage and/or current inversion and loss of directionality in the case of using directional line protective relays. Recently some research efforts have been focused on protection and fault location for series compensated transmission lines . This paper describes an approach to locate fault distance for a series compensated transmission line from the sampling of voltage and current waveforms and later tried to enhance the accuracy of the proposed work with different combinations of Low pass filters. The technique is tested on different systems for different types of faults with different combination and stages used in RC filters.

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