Fault Detection of Six-Phase Transmission Lines using Discrete Wavelet Transform

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Abstract
This paper discusses about the detection of faults in six-phase transmission line by using discrete wavelet transform (DWT). Now a days power utilization is drastically increasing, so the need of enhancement in power transmission capability is inevitable. To support this situation six-phase transmission system is introduced. This will increase the power transferring capability of the system with same right of way as 3Ø transmission lines. The major problem in six-phase transmission line is fault protection and detection. Here wave let transformer is used to detect the fault in six-phase transmission line based on the phase currents. The 100km test system is taken for analysis and simulation results are presented to the proposed concept.

Keywords: DWT, Six phase system, fault detection.

1. Introduction

Now a day the power utilization is going on increasing due to world industrialization. The major factors effecting on efficiency of utility system is reliability of power supply. To enhance power transferable capacity three ways are presented, (1) EHV transmission lines (2) HVDC transmission system (3) six-phase transmission line. Among this EHV and HVDC system have some draw backs, those are high conversion cost and in HVDC obscene of circuit breakers (CB). The six phase transmission line has enhanced power transferring capability with same right of way. The transmission system works with reduced stress because of less radio interference and corona effect is reduced.

The conventional relay protection is complex for multi-phase transmission line compared to three phase transmission line. Here DWT is used for fault detection in six phase transmission line. DWT takes less time to detect the fault in six-phase line. It analyse fault current from system, divided into no of samples than compared with its threshold values. Based on this steady the fault on the system will detect.
2. Test System Description

The six-phase transmission line used for test is 199kV; 50Hz with 180MW of load is used. The six phase system model taken for test is shown in fig 1. The test system is subjected to different types of faults. The basic combinations are 6P-G, 5P-G, 4P-G, 3P-G, and 2P-G and single phase fault.

![Fig.1. Six Phase Transmission Line Power System under Study](image)

3. DWT System Design

The wavelet transform is a mathematical tool, much like a Fourier transform in analysing a stationary signal, which decomposes a signal into different scales with different levels of resolution by dilating a single prototype function. Representation of signals using Fourier transform provides frequency information and it lost time information, but the wavelet transform provides information of both time and frequency for a given signal, therefore, it is suitable for analysing a signal where time-frequency resolution is needed. Such as disturbance transition events in power quality. DWT is used for wavelet analysis and a kind of multi resolution analysis, where the signal is analysed at different frequencies with different resolutions. The analysed signal is then decomposed into approximation and detail coefficients. The approximation coefficients are further decomposed into another set of approximation and detail coefficients. The process is then repeated and the successive stages of decomposition are known as scale-1, scale-2, etc. The detail coefficient of scale 1 (D1) contains the high frequency information of the signal. The choice of the mother wavelet plays a significant role in the analysis and db-4 mother wavelet has been adopted in this paper. DWT is defined by the equation.

Here DWT takes input from test system, than applies db4 type of wavelet to the input current from test system. The db4 can divide one cycle into 101 impulse samples. The converted samples magnitude is compared with the threshold value given for fault detection. From these comparisons fault condition will detected.
4. System Analysis

The 199KV, 50HZ test system is subjected to fault at 0.3sec. The fault resistance of the system is 350Ω and it will clear at 0.4sec. The current under fault condition is taken for detection. The measure current under fault sampled using db4 type of discrete wavelet transform. Here db4 can divide one cycle into 101 impulse samples, total system is divided into 20001 samples. The total signal will be divided into approximation coefficients detailed coefficients which are detailed as for testing. Here maximum value of detailed coefficient is taken for finding fault.

The detection process is done in iterative manner, i.e., initially iteration count fi=0, the iteration is done up to f=20001. Every instant the count is incremented by 1 (f=fi+1). Fig.2 shows the measured current of test system under 6-phase fault. The fault is applied At 0.3sec, then the current is increased drastically as shown in fig. 2, and the fault is cleared at 0.4sec. Fig.3 shows the 3-phase to ground fault from 0.3-0.4sec, that’s why only three phase currents are increased drastically. The applied DWT will displays which phase is subjected to fault.

Fig.2 6-phase to ground fault

Fig.3 5-phase to ground fault
Fig. 4 4-phase to ground fault

Fig. 5 3-phase to ground fault

Fig. 6 2-phase to ground fault
The systems under different fault conditions are tested using DWT. Fig. 3, 4, 5, 6 and 7 show 5P, 4P, 3P, 2P and 1P-G fault currents.

5. Conclusion

This paper defines fault detection in six-phase transmission line is performing using discrete wavelet transform (DWT). DWT can detect the fault faster than conventional relays and design of protection system complexity reduces. The level of DWT used for detection of fault increases, the accuracy of detection increases. The utilization of db4 DWT are resents 4-level computation, it will increases detection efficiency.

References


