

Sequence Components Based Fault Analysis in Series Compensated Line Using Wavelet Transform

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ABSTRACT: This paper presents a wavelet transform based sequence component analysis of LG fault in a series compensated transmission line. The fault current is expressed in terms of its sequence components and further processed using wavelet transformation technique to extract the fault data. The wavelet entropy is calculated using Daubechies wavelet, level 5 of sequence components of fault current detailed coefficients. The 5th level details extracted from positive sequence component of current show higher energy level which is used to detect the fault on the line.

KEYWORDS: DFT, Wave Entropy, MATLAB

I. INTRODUCTION

Electrical systems occasionally experience short circuits. These short circuits are hazardous to the safety of both equipment and people [1]. Though the protective devices will isolate the faults safely, the parts of the system should withstand the resulting mechanical and thermal stresses. Fault impedance and current estimates also form input for the setting and coordination of protective devices like overcurrent relay, distance relay etc. Hence it is very important to estimate the magnitude of the fault currents. The equipment's are selected based on this value. Fault currents can be estimated by either by hand calculation or by fault analysis program. Faults in a 3 phase system can be single line to ground, line to line ground, line to line or three phase[2]. Power system operation during any of these faults can be analyzed using sequence components[3]. This work analyses the faulted phase currents by reducing them into their sequence components in Mat-lab using Daubechies wavelet instead of directly filtering the phase current. The reduction of unbalanced vector and applying transforms can improve the accuracy of fault detection system in automated power systems

II. RELATED WORK

DISCRETE WAVELET TRANSFORM

DWT is used in this work to analyse the sequence components of faulted phase variables. DWT is proved more efficient in extracting the transient features from the faulted current when compared to other signal processing techniques like DFT. With the time-frequency localization characteristics embedded in wavelets, the time and frequency information of a waveform can be presented as a visualized scheme. This feature is very important for non-stationary signals analysis such as the ones generated from power system disturbances. Unlike the Fourier transform, the wavelet transform approach is more efficient in monitoring fault signals as time varies [4]. Unlike Fourier analysis, which relies on a single basis function, wavelet analysis uses basis functions of a rather wide functional form such as Haar wavelet and Daubechies wavelet. This new form of signal analysis is far more efficient than Fourier analysis whenever a signal is dominated by transient behavior or discontinuities[5][6]. The Wavelet Transform (WT) of a continuous signal $x(t)$ is defined as

$$WT(a, b) = \frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} x(t) g\left(\frac{t-b}{a}\right) dt$$

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Where a and b are the scaling and translation parameters respectively and g is the mother wavelet function. The DWT is defined by

$$DWT[m, k] = \frac{1}{\sqrt{a_0^m}} \sum_n x[n] g\left[\frac{k - na_0^m}{a_0^m}\right]$$

Where $g[n]$ is the mother wavelet, and the scaling and translation parameters a and b are functions of an integer parameter m . MRA based wavelet transforms is being applied for decomposing the faulted signal into its details and the Schematic Diagram of Multi-resolution Analysis based decomposition has been given in fig 1.

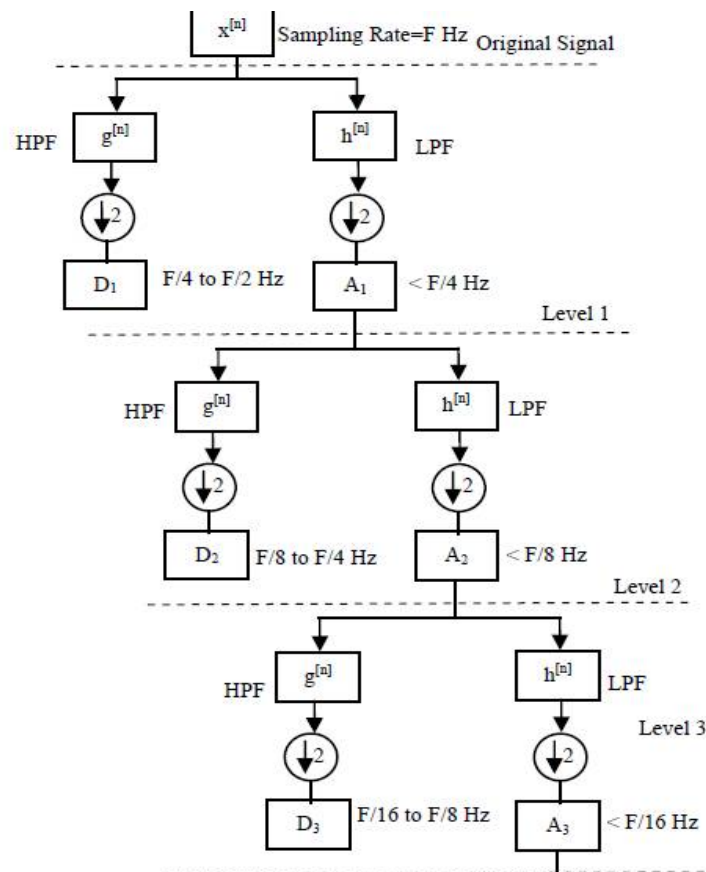


Fig 1. Schematic Diagram of Multi-resolution Analysis of DWT Decomposition

III. MATLAB MODEL

TRANSMISSION LIE MODEL

A three-phase, 60 Hz, 735 kV power system transmitting power from a power plant consisting of six 350 MVA generators to an equivalent network through a 600 km transmission line. The transmission line is split in two 300 km lines connected between buses B1, B2, and B3. In order to increase the transmission capacity, each line is series compensated by capacitors representing 40% of the line reactance. Both lines are also shunt compensated by a 330 Mvar shunt reactance. The shunt and series compensation equipments are located at the B2 substation where a 300 MVA 735/230 kV transformer with a 25 kV tertiary winding feeds a 230 kV, 250 MW load. The series compensation subsystems are identical for the two lines. For each line, each phase of the series compensation module contains the series capacitor, a metal oxide varistor (MOV), protecting the capacitor, and a parallel gap protecting the MOV. When

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the energy dissipated in the MOV exceeds a threshold level of 30 MJ, the gap simulated by a circuit breaker is fired. CB1 and CB2 are the two line circuit breakers.

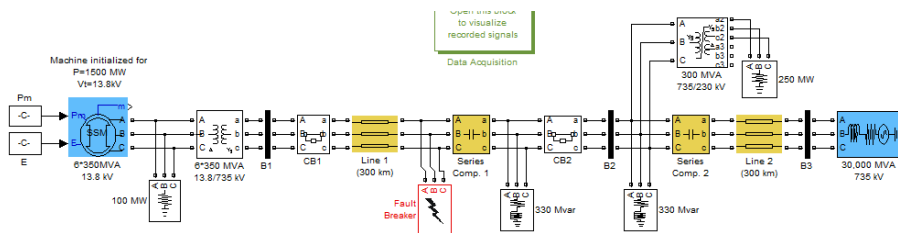


Fig 1. Matlab model for fault analysis

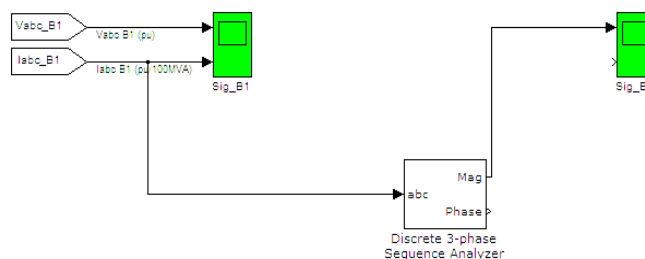


Fig 2. Schematic Diagram of sequence components of fault current

IV. RESULT& CONCLUSION

The energy details of the detailed coefficients of positive sequence components of faulted phase current is analysed using wavelets and is compared with non-faulty system parameters. The analysis is done using Daubechies wavelet (DB4 & DB5) and the results are tabulated below

S.NO	WITH FAULT					WITHOUT FAULT				
DB4	0.0176	0.0154	0.0258	0.0564	0.1912	0.0146	0.0172	0.0165	0.0927	0.0567
DB5	0.0211	0.0185	0.0309	0.0676	0.2304	0.0175	0.0206	0.0198	0.1111	0.0683

Table 1. Entropy of positive sequence component details of phase current

The accuracy of the fault detection system can be improvised for complex systems in terms of the time taken for fault detection by relays by reducing the unbalanced fault vectors into their sequence components. The signal extracted from sequence components using any signal processing technique gives much deeper vision into the transient information. This work can further be extended for comparing the faulty system analysis with and without reducing into sequence networks

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