International Journal of Electronics Engineering, 4 (2), 2012, pp. 221–223

A New Algorithm for Numerical Distance Protection of Series Compensated T- Model Transmission Line

Kumar Dhiraj[1] and F. Ansari[2]

[1]*BRCM College of Engg. & Tech., Bahal, Haryana, India, (e-mail: kumardhiraj9@gmail.com)*

[2]*BIT Sindri, Dhanbad, Jharkhand, India.*

Abstract: In this paper the analysis of numerical protection algorithm is applied to T-Transmission line, the analysis evaluates the numerical distance protection relay algorithms. The simulation of the distance algorithm is based on the one cycle discrete Fourier filter.

1. INTRODUCTION

Due to capacitor, the reactive power control has appeared, since the voltage in receiving end become out of limits during maximum loading conditions.

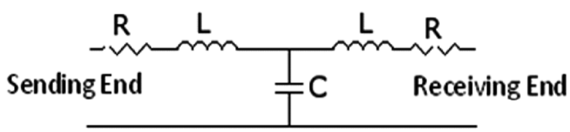

Figure 1

Now, this type of Transmission line compensated in series, the series capacitor banks in the transmission corridor.

What so ever the size of the transmission line increases, the line protection must be provided, in such a way that fault over the line can be identified and eliminated correctly.

Also the use of the series capacitor may not be restricted to specific transmission line. But can be applied in other parts of the power system in the neighborhood of the transmission line to be protected. Again the line protection must be able to correctly operate for this condition.

The insertion of series capacitors brings other phenomena in which the protection devices should be able to respond correctly. There are three types: (i) Voltage inversion (ii) current inversion (iii) sub harmonic frequencies.

This paper is focused on the need of better understanding & the functionalities performed internally within the protection relay, mainly concerning their application in series compensated networks. Therefore, main task an attempt to reproduce some of internal algorithm. These algorithms are used to estimate electrical quantities that will be checked in order the relay to decide it operate or not.

There are two algorithms for distance protection approach: (i) one cycle discrete fouries filter, (ii) Line differential equation model

This paper is focused on one cycle discrete fourier filter using window technique.

2. DESIGN CONSIDERATION OF DISCRETE FOURIER FILTER USING WINDOW TECHNIQUE

Firstly analog signal is converted in to discrete form then consider a rectangular pulse in one and half cycle of the analog signal. Consider a magnitude response of a rectangular pulse

$W_R[n] = 1$for , n = 0,1,2,………M-1

= 0 Otherwise

$$h[n] = h_d[n].W_R[n]$$

Fourier transform of $W_R[n]$ is

$$W_R[w] = \sum_{n=0}^{M-1} W_R[n]e^{-jwn}$$

$$W_R[w] = \sum_{n=0}^{M-1} e^{-jwn}$$

$$W_R[n] = u[n] - u[n-M]$$

$$W_R[w] = \sum_{n=0}^{\infty}\{u[n]-u[n-M]\}e^{-jwn}$$

$$W_R[w] = \sum_{n=0}^{\infty} u[n]e^{-jwn} - \sum_{n=0}^{\infty} u[n-M]e^{-jwn}$$

$$W_R[w] = \frac{1}{1-e^{-jw}} - \frac{e^{-jwM}}{1-e^{-jw}}$$

$$W_R[w] = \frac{e^{-jw\frac{M}{2}}[2\sin\frac{wM}{2}]}{e^{-j\frac{w}{2}}[2\sin\frac{w}{2}]}$$

$$W_R[w] = e^{-jw\frac{(M-1)}{2}} \left[\frac{\sin \frac{wM}{2}}{\sin \frac{w}{2}} \right]$$

The second part of right hand side gives the two sine function. A low pass filter design to remove the side lobes and gives only main lobes. It also gives the fundamental frequency to reach the steady state condition.

3. DIFFERENTIAL EQUATION MODEL

This type of algorithm is based on the system model, instead of signal model, as above shown for the fourier algorithm. The T-Type transmission line represents the differential equation in terms of $v(t)$ and $i(t)$.

$$v(t) = Ri(t) + L\frac{di(t)}{dt}$$

It must be observed that both current and voltage can be measured, but it is not possible to measure the value of the derivative of the current. There are two methods for measuring the value of derivative: (i) Elimination of the derivative by integration, (ii) Approximation of the derivative using samples.

Depending on the method used, the estimation of the parameters can be accomplished by using three samples of current and three samples of voltages only, making this algorithm faster than some others although this short window could be interpreted as non selective compared to others.

4. NUMERICAL ALGORITHM

In order to evaluate and analysis the behavior of numerical relays, we should implement some of the calculations that these devices fulfill internally. These calculations are known as numerical algorithm or digital filter and are responsible for the estimation of electrical parameters needed to provide relay with references for its operation.

In this paper it was decided to implement the one cycle fourie filter and the line differential equation model for the distance protection.

5. SIMULATION

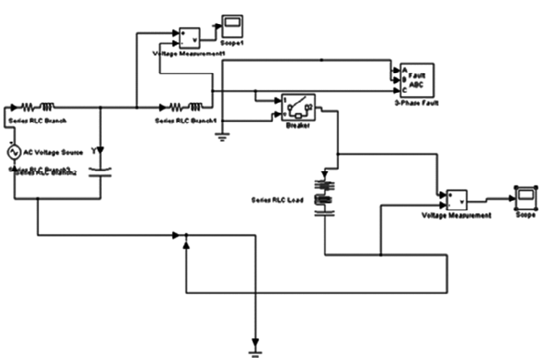

Figure 2

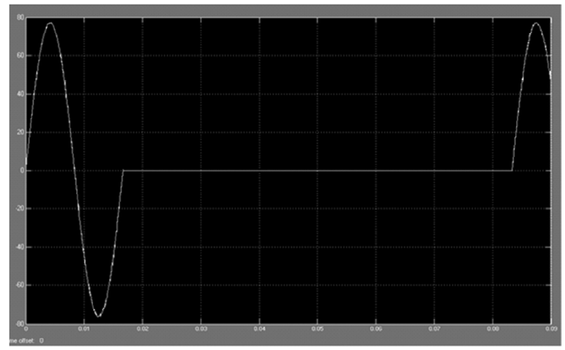

Figure 3

The behavior of the algorithm developed, it is important to define a sample of a power system in which some fault will be applied in fig shown below. The T type transmission line is modeled as a typical 440V line with distributed parameters and all simulations were performed using matlab/ simulink.

Initially, the algorithm has been for a non compensated transmission line and the behavior of the algorithm can be verified for a non compensated system. i.e. the transmission line does not have a series capacitor installed. The fault can be analyzed at different fault position along the line, fault resistance value of faults (single phase) the fault time also shown in Figure (3).

6. COMPUTATION OF APPARENT IMPEDANCE

The real and imaginary components of the fundamental frequency voltage phasor i.e. V_S and V_C and real and imaginary component of the fundamental frequency current pharos i.e. I_S and I_C are obtained by using the given equation below for full cycle window algorithm

$$V = V_S + jV_C$$

$$I = I_S + jI_C$$

$$V = \sqrt{V_S^2 + V_C^2}$$

$$I = \sqrt{I_S^2 + I_C^2}$$

$$\phi_V = \tan^{-1}\frac{V_C}{V_S}$$

$$\phi_I = \tan^{-1}\frac{I_C}{I_S}$$

$$\phi = \phi_V + \phi_I$$

$$Z = \frac{V}{I}$$

$$Z = \frac{V_S + jV_C}{I_S + jI_C}$$

$$Z = \frac{V_S I_S + V_C I_C}{I_S^2 + I_C^2} + j\frac{V_S I_S - V_C I_C}{I_S^2 + I_C^2}$$

$$R = \frac{V_S I_S + V_C I_C}{I_S^2 + I_C^2}$$

$$X = \frac{V_S I_S - V_C I_C}{I_S^2 + I_C^2}$$

The response between R & X as shown below in Figure (4).

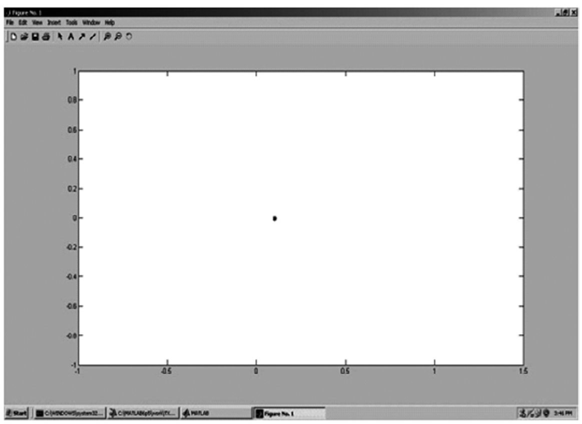

Figure 4: Response of Digital Window Technique

7. RESULT

From differential equation it have seen that at R = 0Ω, X = 4 but in digital form we have X = 0, R = 0.2Ω, for the digital form the resistance becomes low.

REFERENCES

[1] F. Andersson and W. Elmore, "Overview of Series-Compensated Line Protection Philosophies", Western Relay Protective Conference, Washington State University, Spokane, Washington, October 1990.

[2] J. Cheetham, A Newbould, and G. Stranne, "Series-Compensated Line Protection: System Modelling and Test Results", 15th Annual Western Relay Protective Conference, Washington State University, Spokane, Washington, October 1988.

[3] D. L. Goldsworthy, "A Linearized Model for MOV Protected Series Capacitors", IEEE/PES 1986 Summer Meeting.

[4] IEEE Tutorial Course, "Computer Relaying", 1979.

[5] IEEE Tutorial Course, "Advancements in Microprocessor Based Protection and Communication", 1997.

[6] A.G. Phadke, J. S. Thorp, "Computer Relaying for Power Systems", Reseach Studies Ltd., Taunton, Somerset, England, 2000.

[7] M. Akke, J. S. Thorp, "Improved Estimates from the Differential Equation Algorithm by Median Post Filtering", Developments in Power System Protection, 25-27th March 1997, IEE, 1997.

[8] M. Akke, J. S. Thorp, "Some Improvements in the Three Phase Differential Equation Algorithm for Fast Transmission Line Protection", Sydkraft AB & Cornell University.

[9] M. Ramamoorty, "Application of Digital Computer to Power System Protection", *J. Inst. Eng. India,* 1972, 52, pp. 235-238.

[10] J. G. Gilbert and *et. al.,* "High Speed Transmission Line Fault Impedance Calculation Using a Dedicated Minicomputer", *IEEE Transactions on Power Apparatus and Systems,* Vol. PAS-94, No. 3, May/June 1975, pp. 872-883.

[11] W. D. Breingan and M. M. Chen, "The Laboratory Investigation of a Digital System for the Protection of Transmission Lines", IEEE Trans. 1979, PAS-91, pp. 350-358.