Journal of Engineering and Applied Sciences 13 (Special Issue 7): 5593-5598, 2018
ISSN: 1816-949X

LabVIEW Based Fault Locator in Transmission Lines

P. Sridhar, A. Sathishkumar and P. Mallikarjuna Sarma
Department of Electrical and Electronics Engineering, Institute of Aeronautical Engineering College, Hyderabad, India

Abstract: Power is essential need for the economic development of any country. Power stations, transmission lines and distribution systems are the main components of an electrical power system. Analysis of different types of fault is an important and complex task in a power system. Accurate determination of fault location distance to fault in transmission lines. The mathematical models accurately calculate the impedance and actuate the corresponding circuit breaker depending on the value of impedance. Aim of this study is to design a distributed parameter line model and devise a system to distinguish between faults in a nearby zone and a remote zone. The method used in this study is to detect the fault as a ratio of volt/ampere method. To analyze this method an algorithm based on mathematical model short line which utilizes unsynchronized data from sending end of the transmission line. The samples of recorded voltage and currents are used for the calculation of distance. These current and voltage samples are used to develop algorithm in LabVIEW to obtain faulted impedance of a line. LabVIEW Software is a graphical programming language that is program with function blocks replacing text based programming can bring our vision to life with LabVIEW.

Key words: LabVIEW, transmission lines, fault location, myDAQ, programming, mathematical model

INTRODUCTION

Overhead lines are usually means for transportation of power from sources of generation to load centers resulting in power consumption. Deregulation of the electricity market, economic and environmental requirements have pushed electrical utilities to operate transmission lines close to their maximum limits. Smooth operation of transmission lines is essential to deliver minimally interrupted power supply to consumers who have become more and more sensitive to power outages with the growth in worldwide technology. This necessitates reliable operation of power equipment and satisfaction of consumers. Engineers are hence, pushed to design transmission networks that formulate systems to reliably detect and isolate faults affecting the security of the system (Mokhlis *et al*., 2011; Sacdev and Agarwal, 1986; Kezunovic and Perunicic, 1996).

Faults are caused by nature such as heavy rains, snakes bates, storms, lightning, snow insulation breakdown and short circuit faults caused by birds, tree branches and other external objects. Electrical faults manifest themselves as mechanical damage which must be repaired before returning the line to service. Any fault if not detected and isolated quickly will thus, grow into a system wide disturbance causing widespread outages and even subsequent blackouts (Jiang and Liu, 2000). When a fault occurs on a power system, financial losses can be reduced and the line service can be maintained if the location of the fault can be accurately determined, especially, long distribution are involved occurs over a longer distance or area, thereby improving the security and quality of the energy supply. Transmission lines are normally divided into three zones for the purpose of protection (Girgis *et al*., 1992; Novosel *et al*., 1996; Sadeh *et al*., 2000). The distance relay which is also called impedance relay acquires voltage and current data. A prototype was made using NI myDAQ data acquiusion card. The prototype works on LabVIEW Software (Gopalakrishnan *et al*., 2000; Yu *et al*., 2002; Waikar *et al*., 1994; Girgis and Makram, 1988).

The relay was tested using a prototype model of a short transmission line replaced five times to represent a long transmission line (Shih, 2007). In addition, efficient national instruments based data acquisition system in conjunction with LabVIEW has been incorporated to acquire the best possible representative data with commensurate characterization and transmission with

Corresponding Author: P. Sridhar, Department of Electrical and Electronics Engineering, Institute of Aeronautical Engineering College, Hyderabad, India

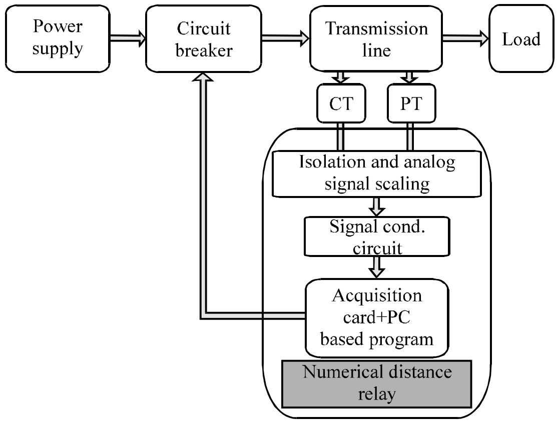

Fig. 1: General block diagram of the proposed protection scheme

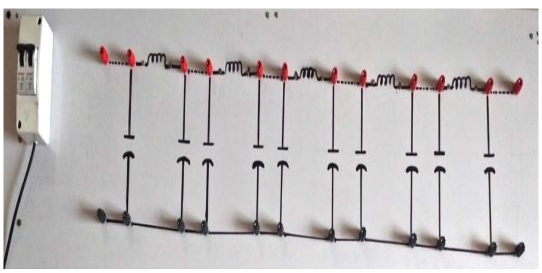

Fig. 2: Front view of distributed parameter line model

fidelity (Wiszniewski, 1983; Schweitzer, 1982). The unique contributions of this real-time fault analysis hybrid model are accurate fault detection using impedance fault location method.

The main objective of this study is to design a distributed parameter line model and devise a system to examine the application of impedance based fault detection in the designed transmission line using LabVIEW interfacing through myDAQ, so that, their effectiveness can be assured.

Hardware model for design of a single phase distributed parameter line model: In electrical engineering, the distributed element model or transmission line model of electrical circuits assumes that the attributes of the circuit like resistance, capacitance and inductance are distributed continuously throughout the material of the circuit (Takagi *et al*., 1982; Nagasawa *et al*., 1992).

In this study, a prototype model, 400 km long distributed parameter model is discussed. It is divided into five π sections. The components used in this designed transmission model are inductors, capacitors, step down transformer, terminals, resistors for voltage and current sensing (Fig. 1-3).

Fig. 3: Back side view of distributed

A distributed parameter model has been modeled. The transmission line length is of 400 km divided into five zones. The transmission line is designed using π- model (Fig. 1-3).

MATERIALS AND METHODS

Software model: In this window, one can simulate all the algorithms needed in the design including phasor estimation algorithms (Fig. 4).

Phasor estimation algorithms: This stage analyzes the signals coming from DAQ assistant and gives us the amplitude and phase of voltage and current in the transmission line.

The sub 4 calculates the impedance from the voltage and current signals obtained from DAQ assistant. The impedance value is compared with transmission line impedance under different short circuited conditions in every zone.

The acquisition of voltage and current signals at the sending end of the transmission line is simulated by two simulate signal blocks. The upper one signifies voltage signal and the lower one signifies current signal. When the actual voltage and current signals are acquired through myDAQ, DAQ assistant block is used. Each of these signals is given to respective amplitude and measurement block whose output is RMS value of voltage and current. The RMS values are multiplied by scaling factors and RMS value of voltage is divided by RMS value of current to get impedance of the line. The impedance is compared with various threshold values and it is determined in which section the fault occurred. If the impedance is >300 Ω the line has no fault. Otherwise, it determines in which section the fault occurred and the information is displayed on the front panel. Tripping of the circuit breaker is affected accordingly (Fig. 4).

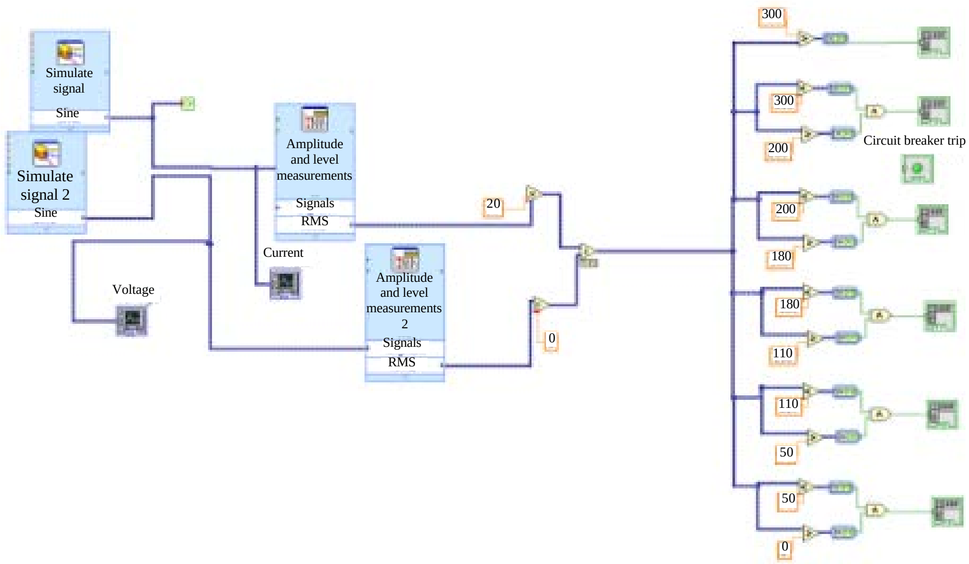

Fig. 4: Block diagram of software module

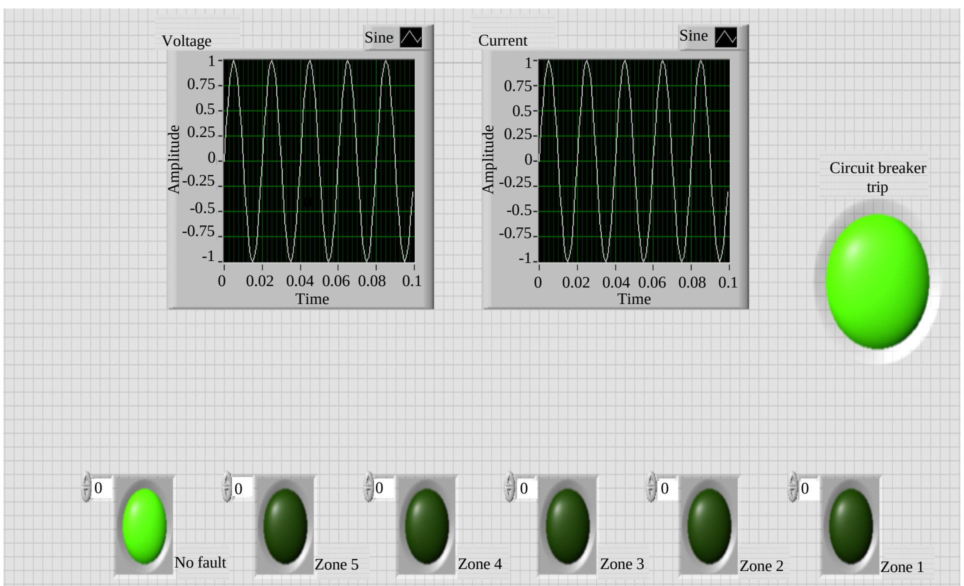

Fig. 5: During healthy conditions in the transmission line

RESULTS AND DISCUSSION

The results of the test being performed are presented using figures which display the LabVIEW front panel of the transmission line model. The sending side and currents voltages are shown in Fig. 5 during healthy conditions. This is the initial position of hardware simulation. In the simulation study, the short circuit faults are simulated at various distances from the source side. The voltage and current waveforms are given in the subsequent figures, i.e., from Fig. 6-10. Figure 6 explains the voltage and current waveform during the fault at a distance of 350 km from source side. Similarly, the voltage and currents are recorded for above distances, i.e., 270, 200 , 120 and 50 km as shown in Fig. 7-10, respectively. The samples are generating by creating faults at various distances and given to fault locator. In this study, unevenly the faults are created and fundamental components of voltages and currents are compared with healthy conditions.

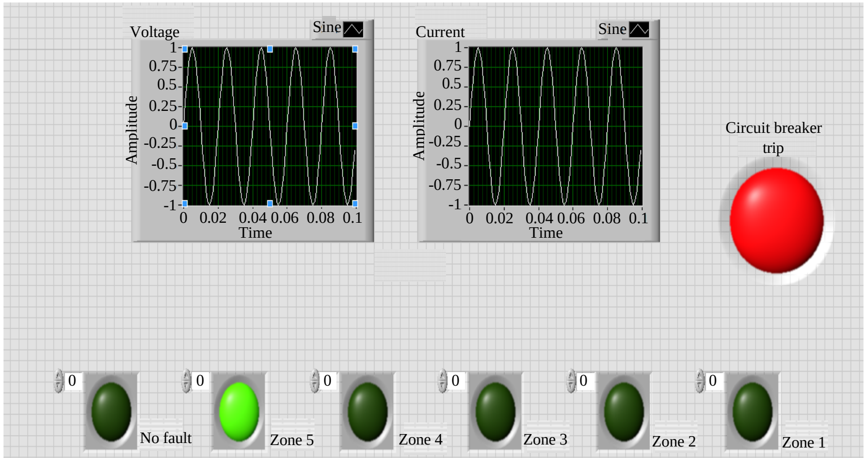

Fig. 6: Short circuit fault at a distance of 350 km

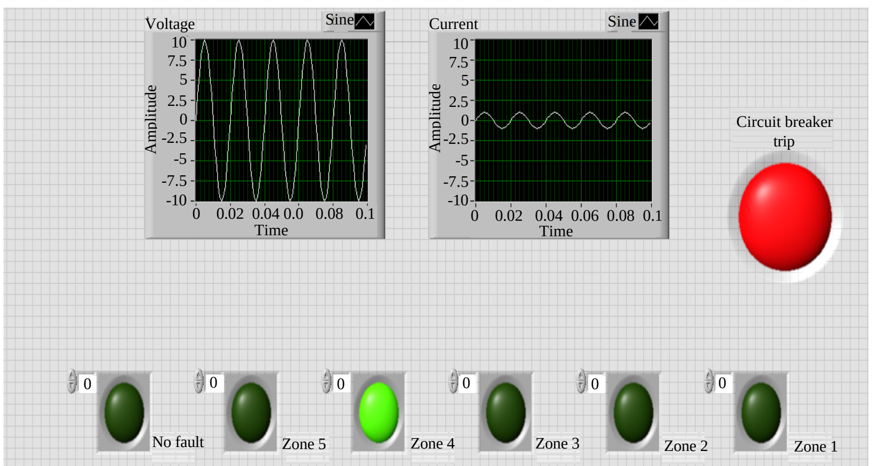

Fig. 7: Short circuit fault at a distance of 270 km

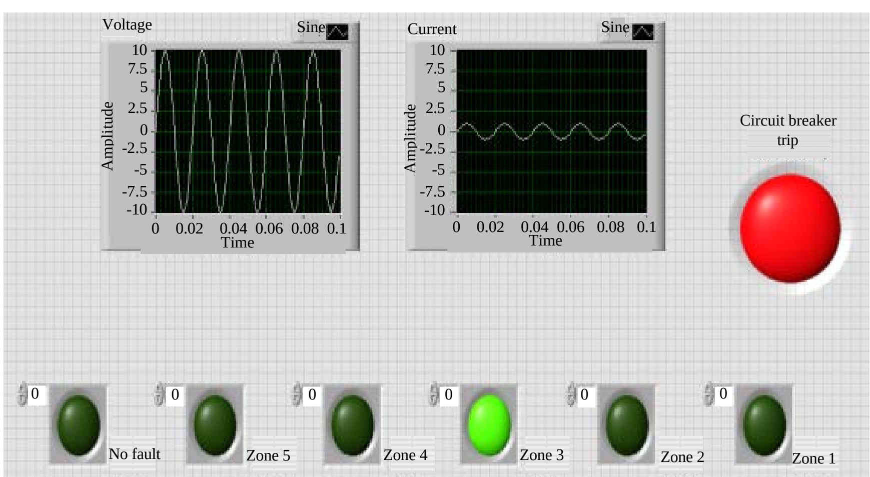

Fig. 8: Short circuit fault at a distance of 200 km

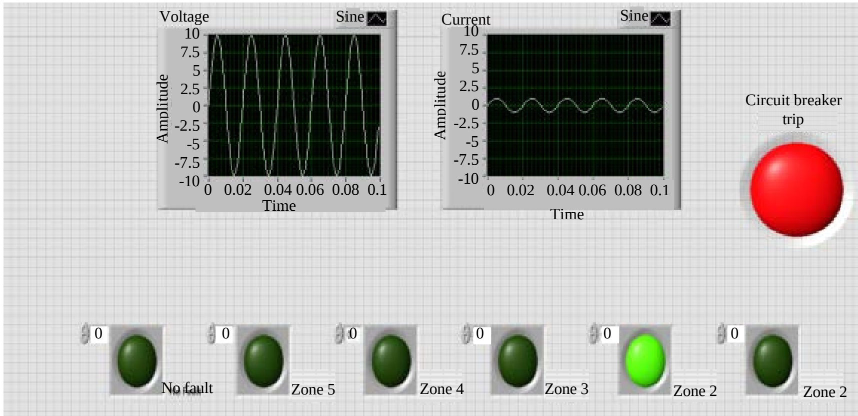

Fig. 9: Short circuit fault at a distance of 120 km

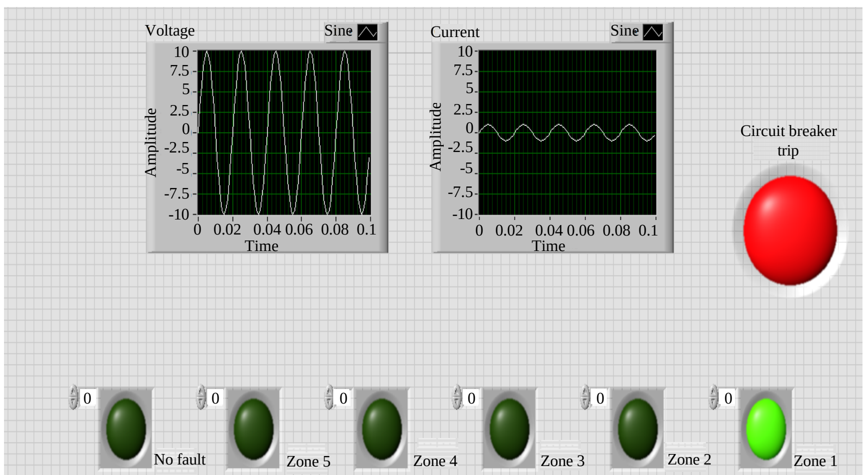

Fig. 10: Short circuit fault at a distance of 50 km

CONCLUSION

Fault on power system should be cleared quickly to enhance damage of equipment of grid, loss of revenue, customer complaints and repair crew expenses. Rapid restoration of service can be achieved if precise fault location algorithm is implemented. Transient stability and reduction in expenditure incurred in repairs. Many algorithms have been developed to calculate the fault distance on the transmission line. This study gives the general overview of fault location calculation on transmission line using impedance based method. It discussed a parametric model of transmission line implemented in the laboratory environment model and fault analysis in the transmission line. This study is suitable for education for showing to the power engineering students the impedance relay principle of function and how to adjust it for protecting the different zones of the transmission line.

REFERENCES

Girgis, A.A. and E.B. Makram, 1988. Application of adaptive Kalman filtering in fault classification, distance protection and fault location using microprocessors. IEEE. Trans. Power Syst., 3: 301-309.

Girgis, A.A., D.G. Hart and W.L. Peterson, 1992. A new fault location technique for two-and three-terminal lines. IEEE. Trans. Power Delivery, 7: 98-107.

Gopalakrishnan, A., M. Kezunovic, S.M. McKenna and D.M. Hamai, 2000. Fault location using the distributed parameter transmission line model. IEEE. Trans. Power Delivery, 15: 1169-1174.

Jiang, J.A. and C.W. Liu, 2000. An adaptive PMU based fault detection/loction technique for transmission lines. I. Theory and algorithms. IEEE Trans. Power Delivery, 15: 486-493.

Kezunovic, M. and B. Perunicic, 1996. Automated transmission line fault analysis using synchronized sampling at two ends. IEEE Trans. Power Syst., 11: 441-447.

Mokhlis, H., H. Mohamad, A.H.A. Bakar and H.Y. Li, 2011. Evaluation of fault location based on voltage sags profiles: A study on the influence of voltage sags patterns. Int. Rev. Electr. Eng., 6: 874-880.

Nagasawa, T., M. Abe, N. Otsuzuki, T. Emura and Y. Jikihara *et al*., 1992. Development of a new fault location algorithm for multi-terminal two parallel transmission lines. IEEE. Trans. Power Delivery, 7: 1516-1532.

Novosel, D., D.G. Hart, E. Udren and J. Garitty, 1996. Unsynchronized two-terminal fault location estimation. IEEE. Trans. Power Delivery, 11: 130-138.

Sacdev, M.S. and R. Agarwal, 1986. A technique for estimating transmission line fault locations from digital impedance relay measurements. IEEE Trans. Power Syst., 3: 121-129.

Sadeh, J., A.M. Ranjbar, N. Hadsaid and R. Feuillet, 2000. Accurate fault location algorithm for series compensated transmission lines. IEEE. Trans. Power Delivery, 15: 1027-1033.

Schweitzer, E.O., 1982. Evaluation and development of transmission line fault-locating techniques which use sinusoidal steady-state information. Proceedings of the 9th Annual Conference on Western Protective Relay, October 26-28, 1982, Elsevier, Spokane, Washington, USA., pp: 269-278.

Shih, W.C., 2007. Time frequency analysis and wavelet transform tutorial wavelet for music signal analysis. Master Thesis, Graduate Institute of Communication Engineering, National Taiwan University, Taipei, Taiwan.

Takagi, T., Y. Yamakoshi, J. Baba, K. Uemura and T. Sakaguchi, 1982. A new algorithm of an accurate fault location for EHV-UHV transmission lines: Part II-Laplace transform method. IEEE. Trans. Power Apparatus Syst., 101: 564-573.

Waikar, D.L., S. Elangovan and A.C. Liew, 1994. Fault impedance estimation algorithm for digital distance relaying. IEEE. Trans. Power Delivery, 9: 1375-1383.

Wiszniewski, A., 1983. Accurate fault impedance locating algorithm. IEE. Proc. C. Gener. Transm. Distrib., 130: 311-314.

Yu, C.S., C.W. Liu, S.L. Yu and J.A. Jiang, 2002. A new PMU-based fault location algorithm for series compensated lines. IEEE. Trans. Power Delivery, 17: 33-46.