Comparative Analysis of Fault Detection in Transmission Line Using Phasor Measurement Units

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Abstract- *Fast and Accurate Fault Location is critical to restoration of the power system. Several methods for fault location using synchronized phasor measurements have been listed in literature review.Some of the listed methods use voltage and current measurements at one end or use two ends measurements. Other methods use synchronized voltage measurements only to eliminate the errors of current transformers.This paper regenerates the method using only voltage measurements and suggests a new algorithm using both voltage and current measurements with higher degree of accuracy.The proposed fault detection technique is based on Positive Sequence voltage and current measurement from PMUs.The proposed algorithm is tested for Standard IEEE 9 bus system using MATLAB/SIMULINK. Illustrative results are presented for various type of faults.*

***Keywords* -** Phasor Measurement Units, Positive Sequence Voltage Measurement (PSVM), Digital Protection, Positive Sequence Current Measurement (PSCM)

I. INTRODUCTION

Transmission systems are more becoming more stressed due to increased loads and inter-utility power transfers. Power system needs to be operated to satisfy high reliability standard, low operational cost and minimum environmental effect. For the power system to work efficiently, proper monitoring is to be done and accordingly, control actions are to be taken.

Phasor measurement unit (PMU) is introduced in power systems resulting in real time wide area management system (WAMS). The added advantage is that the PMUs are time synchronized and data are obtained from various buses at the exact same time. Thus, dynamic variations of a power system can be monitored through WAMS. WAMS is the most important network developed over the vast geographical area overlaying the power network infrastructure. In WAMS, PMU plays very crucial role in the next generation smart grid protection and control. PMUs take this picture at the same reference time. Using real-time information from PMUs and automated controls to predict, identify, and respond to system problems; a smart grid can automatically avoid or diminish power outages, power quality problems and supply disruptions.

The rest of the paper is organized as follows: In the section 2 theoretical background is presented. Section 3 gives the development of Fault detection method and its implementation. Section 4 deals with simulation model and simulation results in Matlab/Simulink. Section 5 concludes the research findings.

II. THEORETICAL BACKGROUND

Phasor Measurement Unit (PMUs) are high speed power system devices which provides time-stamped synchronized measurements of phasor of voltage and currents in a real time which then be used for calculating voltage and current magnitudes, phase angles, real and reactive power flows, etc. The synchronization is achieved by the same time sampling of voltage and current waveforms from Global Positioning System (GPS) satellite timing signals. Synchronized phasor measurement gives the standards of power system monitoring, control and protection of the system to new level.The advantage of referring phase angle with reference to global time is helpful for protection, monitoring and control of wide area power system

PMUs technology provides phasor information (both magnitude and phase angle) in real time. The advantage of referring phase angle to a global reference time is helpful in capturing the wide area snap shot of the power system. Effective utilization of this technology is very useful in mitigating blackouts and learning the real time behavior of the power system.

With the advancement in technology, the micro processor based instrumentation such as protection Relays and Disturbance Fault Recorders (DFRs) incorporate the PMU module along with other existing functionalities as an extended feature. Recent spate of spectacular blackouts on power systems throughout the world has provided an added impetus to widescale deployment of PMUs. Positive sequence measurements provide the most direct access to the state of the power system at any given instant.

III. FAULT DETECTION ALGORITHM

3.1 Proposed Technique

A novel hybrid technique is proposed to detect transmission line faults in an Interconnected Network using the measurements from Phasor Measurement Units (PMUs). The proposed fault detection technique is based on Positive Sequence voltage and current measurement from PMUs.

In our proposed algorithm, two approaches are used. In our first approach, the values of PSVMs are observed. If there is any change in magnitude of PSVMs then change is sequence is checked. If there is change in sequence, so the area that changes the sequence is the faulty area. If there is no change in the sequence then minimum value of PSVM detects the bus/area nearest to fault. Our second approach starts if the first approach fails to detect the faulty area. First approach would be failed to detect the minimum PSVMs. In our second approach, The magnitude of PSCMs is observed. If there is any change in sequence of PSCMs then the area that changes the sequence is called the faulty area otherwise the maximum value of PSCM detects the bus/area nearest to fault

3.2 Simulink Model

The simulation models are developed using MATLAB/Simulink with SimPower Systems. It is then used to simulate various short circuit faults. The models are developed with minimum number of blocks in mind and use their default settings whenever possible to reserve their simplicity. Figure 1 show the simulink model of advanced PMU.

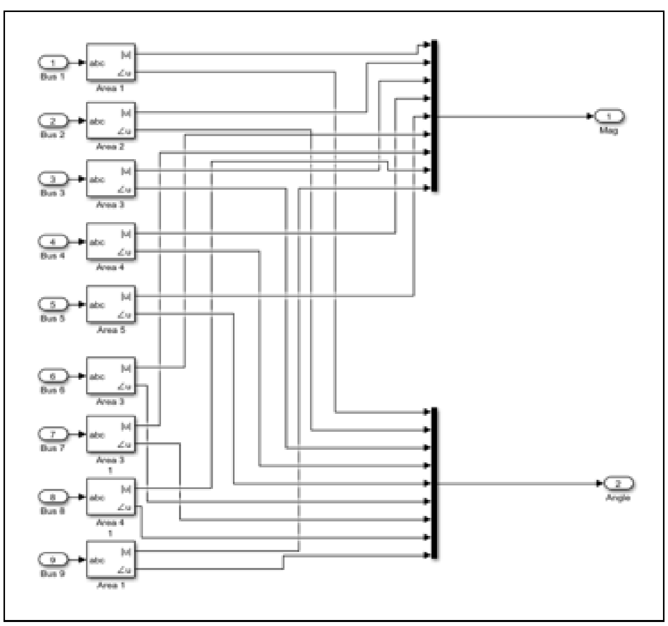

Figure 1 New PMU design for all Buses.

IV. RESULTS

All faults are applied between 0.2 to 0.4 sec in Matlab/Simulink and simulation runs for total of 0.5 sec. Following are the plots obtained at various faults at Bus 8, Fig. 2. Shows the system voltage and current at the bus 8 before fault. In Fig. 3. shows the system voltage and current under line to ground fault. In Fig. 4. shows the System bus Voltage and Current under Line-To-Line Fault.

System Bus Voltage and Current under Double line to ground fault is shown in Fig. 5. In Fig. 6. System Bus Voltage and Current under Three Fault. Fig.7. shows the rate of change of frequency is reduced in during the fault period. Fig. 8 shows the PSVM and PSCM results of the IEEE 9 us system.

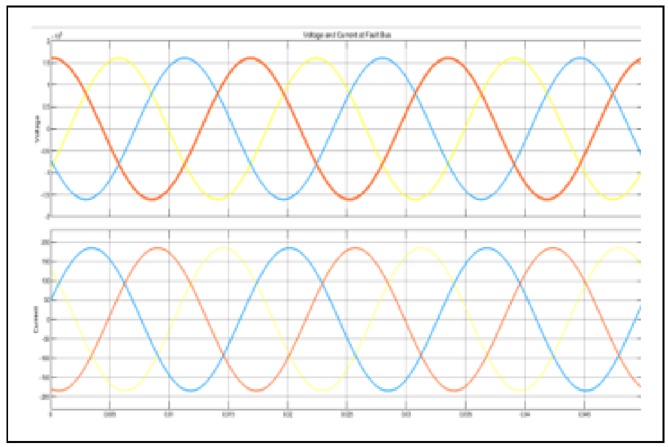

Figure 2 System Bus Voltage and Current before Fault

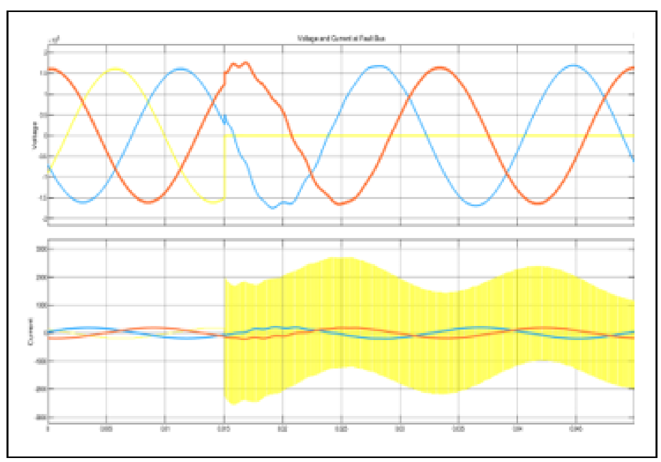

Figure 3 System Bus Voltage and Current under LG Fault

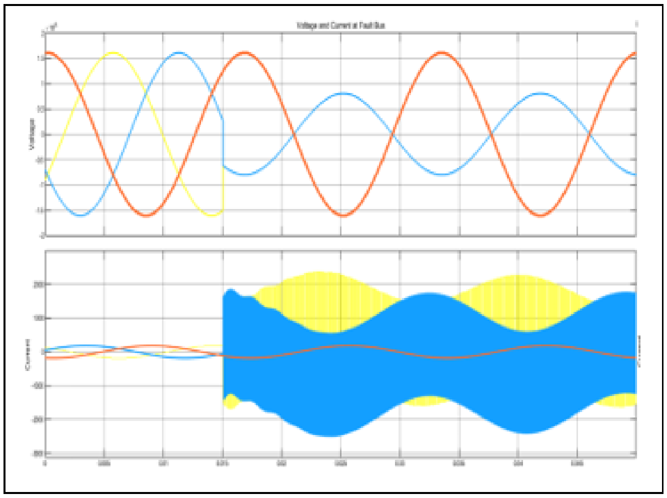

Figure 4 System Bus Voltage and Current under LL Fault

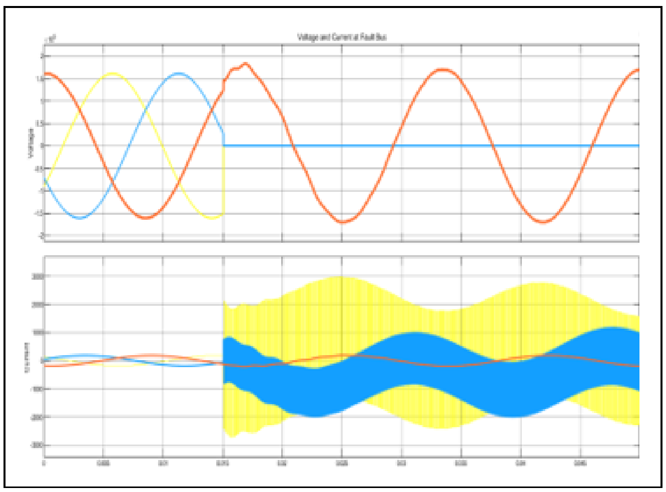

Figure 5 System Bus Voltage and Current under LLG Fault

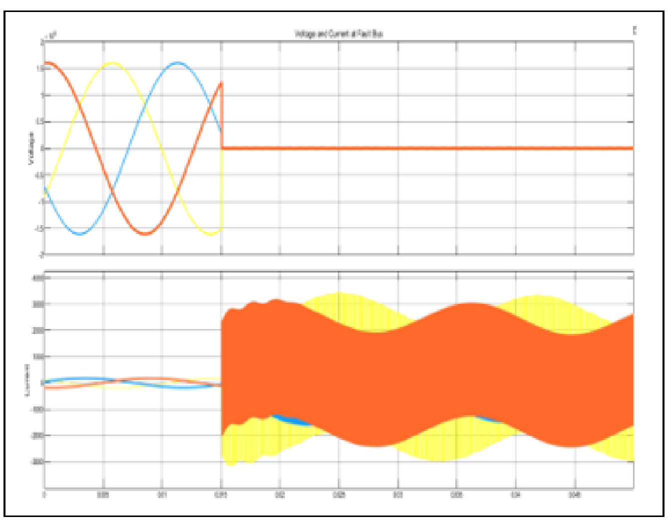

Figure 6 System Bus Voltage and Current under LLLG Fault

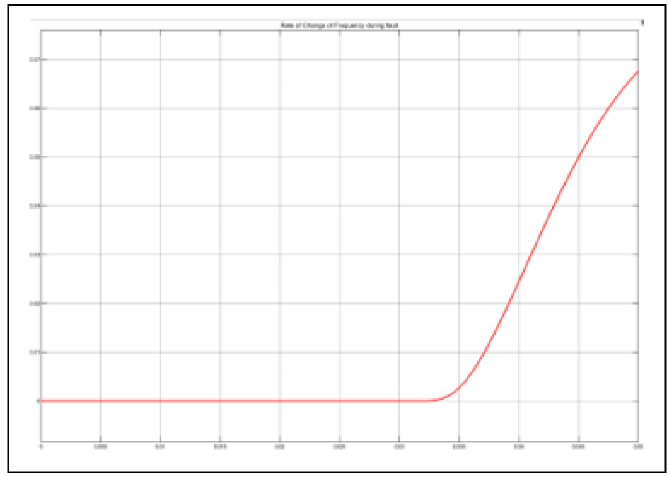

Figure 7 Rate of change of frequency

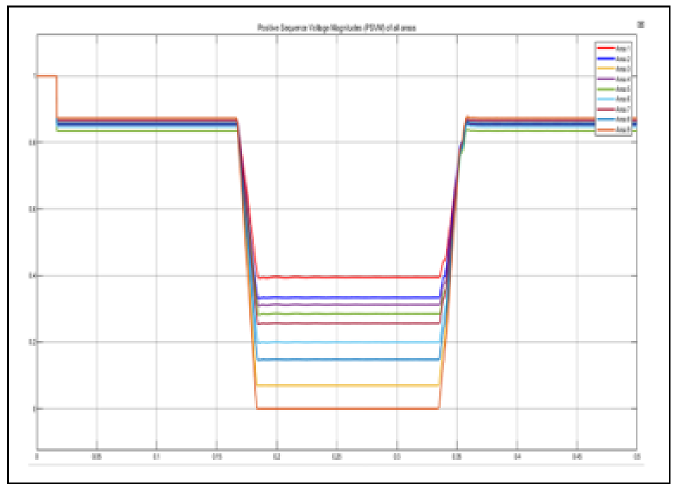

Figure 8 PSVM of all buses

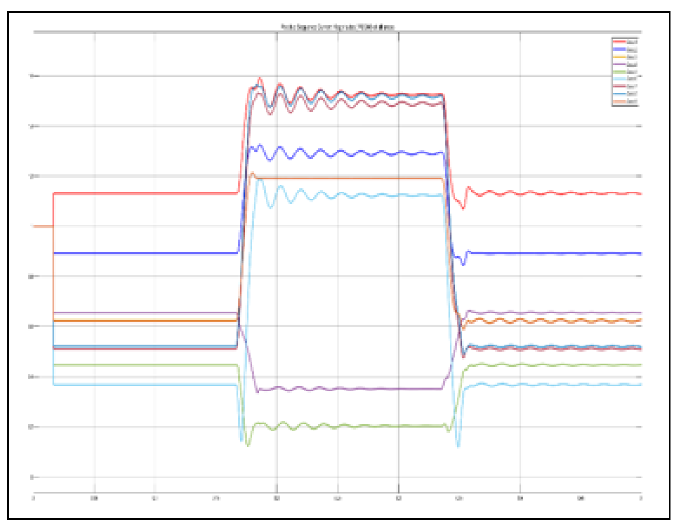

Figure 9 PSCM of all buses

V. CONCLUSION

This paper gives a more efficient algorithm for fault detection using PMU and it try to overcome the various weaknesses of the previous research work.On the basis of the information given by PMU, the bus can be isloted using relay and cicuit breaker. The process of fault detection and identification is carried out in two-stages: 1)the detection of fault using Positive Sequence Voltage Magnitude (PSVM) and identification is completed through Positive Sequence Current Angle Differences (PSCADs). It is shown that in some cases detection and identification is unsuccessful then second stage is used which is based on Positive Sequence Current Magnitude (PSCM). The protection scheme has successfully identified the fault.

The main advantage of the proposed algorithm is that the magnitudes result of all the buses are available in one plot for comparitive analysis. In our system, the PSVM and PSCM values are calculated as magnitude of Vabc in single line form, thereby causing easy for comparison.

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