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PMU Based Fault Detection in 14 Bus System

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ABSTRACT

Accurate location of a fault on a line is extremely important to restore the parameters line in the shortest time as possible, which directly affects the operational cost and system reliability. This paper presents an accurate and fast strategy for fault location based on well-known state estimation method. The proposed method employs PMU measurements records line parameters during the fault (before the circuit breakers open). Those measurements are used for determination of the fault currents flowing on the faulted line and locating the fault using Weighted Least Squares (WLS) estimator. The proposed method reduces the required number of measurements for the solution of the fault location problem by making use of the fast refresh rates of the PMUs.

Keywords: Fault Location, Least Squares Estimation, Phasor Measurement Unit (PMU), State Estimation

I. INTRODUCTION

Power systems are rapidly growing in recent years, It is very difficult to know when this lines are exposed towards faults in different ways such as lightning strokes, storms and short circuits due to contacts of any conducting materials between those line. The line have able to clear the permanent faults in the shortest time, and to increase the power quality and the reliability of the grid, fault location is needed. In the literature many fault location methods are presented. The fault location methods can be divided into two categories. Among the methods presented in the literature, a good number of impedance- based (power frequency based) fault location algorithms have been developed. Those algorithms use bus voltage and line current data of either a single bus (one-ended) or two buses two ended that are connected to the faulted line. Multi-bus algorithms, which use measurements taken from the ends of the multi-terminal transmission lines, are also available in the Literature.

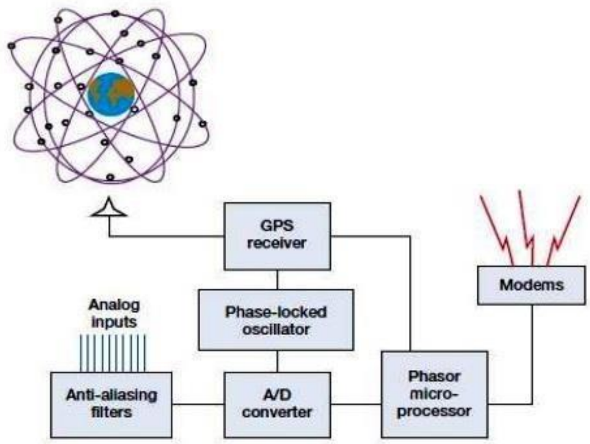

Fig. 1 : Block Diagram of Phasor measurement unit

II. DESCRIPTION

This work proposes a state estimation based fault location method, which employs two- ended algorithm. The method assumes that the considered system is PMU observable, such that the state estimation can be performed using only PMU measurements. In other words, even the system has only bus voltage and line current data of a single bus, other bus data can be estimated if the system is observable. The proposed method firstly performs power system state estimation to determine the voltages of each bus. Assuming the considered system's measurement design is redundant enough, such that bad data can be identified, the fundamental component of the faulted current flowing through the line from both sending and receiving ends can be calculated. Note that this part is especially necessary if sending end and/or receiving end of the faulted line is not measured by a PMU. In order to determine the fault location, Weighted Least Squares (WLS) estimator is employed. The estimation problem is based on the two-ended fault location methods. WLS uses estimates of the line currents and bus voltages as well as the measurements obtained from PMUs for measurement redundancy.

III. PMU PHASOR MEASUREMENT UNIT

A (PMU) is a device used to estimate the magnitude and phase angle of an electrical Phasor quantity like voltage or current in the power system using a common time source for synchronization. Time synchronization is usually provided by Geographical Positioning System (GPS) and allows synchronized real- time measurements of multiple waveforms on grid. PMUs are capable of capturing samples from a waveform in quick succession and reconstruct the Phasor quantity. The resulting measurement is known as a synchrophasor. These devices can also be used to measure the frequency in the power grid. A typical commercial PMU can report measurements with very high temporal resolution in the order of 30-60 measurements per second.

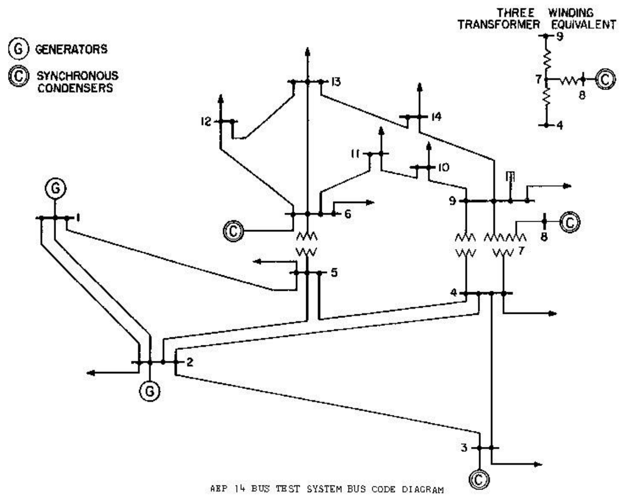

Fig 2 : Block Diagram of PMU Based 14 Bus system

IV. STATE ESTIMATION FOR DETERMINATION OF FAULT CURRENTS

This paper proposes use of state estimation before the current phasor measurements associated running a fault location algorithm to overcome such a problem. In the presence of a redundant enough measurement design for state estimation robustness . After the state estimation, the bad data process, namely normalized residuals test , will flag with the faulted line as bad measurements, because of the model mismatch due to the fault. Even if the EMS does not update the system topology, this strategy will show the faulted line to the system operator. The two-ended fault location methods require current measurements taken at both ends of the faulted line. If a PMU does not exist at the sending end and/or receiving end, results of state estimation can be used to compensate the lack of that current measurement. Otherwise, the proposed method also uses current measurements obtained via the corresponding PMU. Note that, using state estimation in calculation of fault current (to compensate lack of measurement) is possible if there is no power injection at the bus without PMU or the amount of injected power is known. Once the injection power is known, the fault current, If in Fig. 1 can be calculated as follows, using the famous Kirchhoff's Law.

$$I_f = \sum_{k \in N} I_k$$

N represents the set of lines connected to Bus-1. Note that, once the fault occurs the system model corresponding to the faulted line will not be correct any more. Therefore, the fault current cannot be calculated using the voltage estimates of the sending and receiving end buses, but rather should be employed

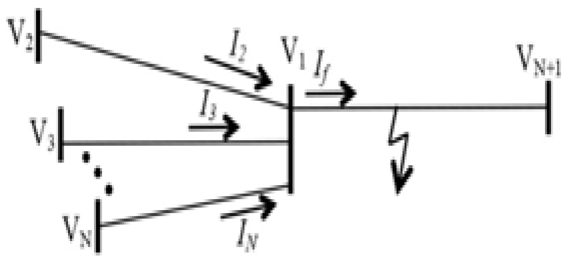

Fig 3. Calculation of fault current using state estimates

V. FAULTLOCATIONBASEDONSTATE ESTIMATION

The synchronized two-ended method solves the two equations in order to locate the fault shown In where Vi, Vj and Vf are the voltage phasors at Bus-i, Bus-j and the fault location, respectively. Fault current flowing through Bus-i is represented by Ifi, while fault current flowing through Bus-j is represented by Ifj. Z represents the series impedance of the line between buses i and j, and bii and bjj represent the line charging susceptances at Bus-i and Bus-j, respectively. Finally, α shows the ratio of the distance of the fault to Bus-i to the total length of the faulted line.

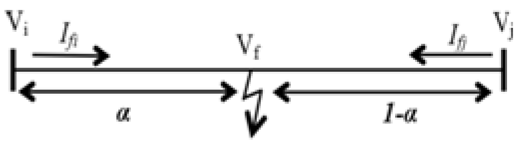

Fig.4 Sample Faulted Line

Conventional two-ended synchronized fault location solves to find α and V_f. It is known that PMU data carry measurement error, which is assumed to be Gaussian.

VI. SIMULATIONS AND NUMERICAL RESULTS

The simulations are performed using IEEE 14- bus system in MATLAB environment. The PMU measurements are placed according to the method presented in . The simulations include Disturbance in voltage and current measurements.

$$I_{fi} = \frac{V_i - V_f}{\alpha Z} + \frac{V_i b_{ii}}{\alpha}$$

$$I_{fj} = \frac{V_j - V_f}{(1-\alpha)Z} + \frac{V_j b_{jj}}{(1-\alpha)}$$

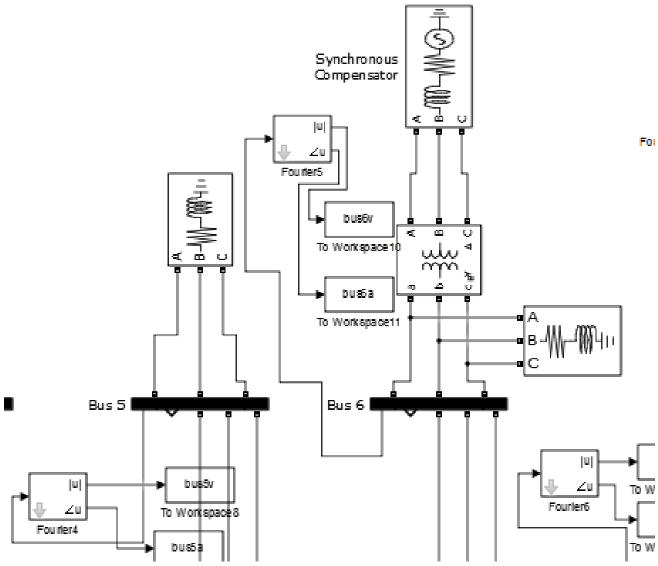

Fig 5. simulated block of 5-6 connected Bus system

Computation of Fault Current

All the V_{bus} currents in the 14 bus system has to be converted from polar to rectangular form because of we are placed an Fourier block in individual bus system in which the block separates magnitude and phase angle in a given bus system .Unsymmetrical fault (AG) is simulated at 1/50 ie. 0.02 sec and the measurements are taken at 0.099sec.Below are the measurements after the fault. First 11 are the bus voltages and remaining are branch currents.

TABLE 1 COMPUTED FAULT CURRENT VALUES

Vbus =

	0.6472 + 0.3575i
0.7816 + 0.3633i	0.3412 + 0.0527i
0.7810 + 0.3226i	0.3932 + 0.0884i
0.6881 + 0.3023i	0.5171 + 0.1709i
0.7117 + 0.3162i	0.6069 + 0.2152i
0.6584 + 0.2571i	0.5487 + 0.2039i
0.5232 + 0.2074i	0.2173 + 0.0479i

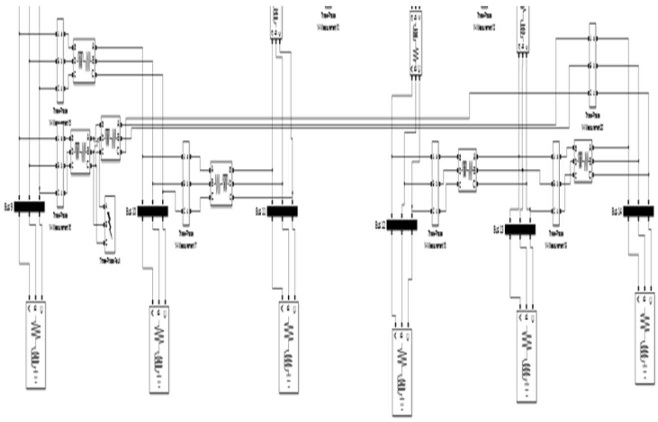

Fig.6: simulated block of fault bus connected between 9 buses to 14 bus system

Here is the predetermined values of the bus system is acquired at data center as we are assumed or connect a fault in between any one of the two bus .Here we connected a fault between 9th and 10th bus with any one of the faults and location in km i.e in pu is defined hear . The main task is to checking the fault location with running with above algorithm using state estimation method is similar to the given fault location nearer to it.

VII. RESULTS AND DISCUSSION

Results of fault currents using weighted least square method

Table 2. COMPUTED WLS CURRENT VALUES

wls_ebus_current

Ebus =

0.7100 - 0.1733i	0.4046 -
0.6970 -	0.6666 -
0.6950 -	0.6942 -
0.6236 -	0.7419 -
0.6414 -	0.5699 -
0.5863 -	0.4841 -
0.5185 -	0.0211 -

The fault is identified with largest normalized residual test. Below are the normalize residuals for 31 PMU measurements

TABLE 3. COMPUTED FAULT CURRENT VALUES

rn =

	0.0249 - 0.0000i
0.1461 + 0.0000i	0.0107 - 0.0000i
0.0728 + 0.0000i	0.0771 + 0.0000i
0.0639 + 0.0000i	0.1865 + 0.0000i
0.1879 + 0.0000i	0.3468 + 0.0000i
0.2559 + 0.0000i	0.2372 - 0.0000i
0.2283 + 0.0000i	0.3469 - 0.0000i
0.1750 + 0.0000i	0.2372 - 0.0000i
0.0287 + 0.0000i	0.3469 - 0.0000i
0.0581 + 0.0000i	0.1367 + 0.0000i
0.2805 + 0.0000i	0.2107 + 0.0000i
0.0235 - 0.0000i	0.1879 - 0.0000i
0.0193 + 0.0000i	0.1206 + 0.0000i
0.0107 + 0.0000i	0.4633 - 0.0000i
0.0193 - 0.0000i	0.5821 - 0.0000i
	0.4087 - 0.0000i

m =0.1854 - 0.0000i

Here is the largest normalized residue of 31 measurements. The 28th measurent i.e the branch from bus 9 to bus 14 is a faulted line .

The output for the given predefined values of faulted location with respective with system parameters

FAULT CONNECTED BETWEEN

R= 0.30*0.12711

L= 0.30*0.27038/(2*pi*50)

R=0.70*0.12711

L= 0.70*0.27038/(2*pi*50)

FAULT LOCATION

Here is the output of the given fault location in pu d=0.324 in bus location in FROM 9 th to 14 th .

fault_loc2

d =0.324

VIII. CONCLUSION

The fault location problem is especially important for the restoration of power, which will increase the reliability of the system and decrease the operational cost. In this work, a fault location technique based on the well- known state estimation methods is presented. Considering their increasing number, high refresh rate and time synchronization, it is proposed to employ PMU measurements to apply the proposed method. Note that, the proposed method is applicable to any synchronized data set. The state estimation based method uses multiple time scans to increase the accuracy of the fault location, and to eliminate the measurement redundancy problem. Thanks to the local problem formulation, the computational burden of the method is very low. The initial condition of the estimation problem is critical, because of the risk of unfeasible solution. Therefore, it is proposed to use small α0 values to initialize the problem. This choice might increase the iterations of the solution, but considering the small size of the problem, the increased number of iterations will not create a significant change in the total solution time of the problem. Note that, all relations are derived for three-phase to ground fault. However, if a three-phase estimator is employed, the proposed fault location method can be applied independent of the fault type.

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X. REFERENCES

[1]. S. Santoso, A. Gaikwad and M. Patel, “Impedance-Based Fault Location in Transmission Networks: Theory and Application,” IEEE Access, vol. 2, pp. 537-557, 2014.

[2]. T. Takagi, Y. Yamakoshi, M. Yamaura, R. Kondow, and T. Matsushima, “Development of a new type fault locator using the oneterminal voltage and current data,” IEEE Trans. Power App. Syst., vol. PAS-101, no. 8, pp. 2892–2898, Aug. 1982.

[3]. L. Eriksson, M. M. Saha, and G. D. Rockefeller, “An accurate fault locator with compensation for apparent reactance in the fault resistance resulting from remore-end infeed,” IEEE Trans.

Power App. Syst., vol. PAS- 104, no. 2, pp. 423–436, Feb. 1985.
[4]. T. Kawady and J. Stenzel, "A practical fault location approach for double circuit transmission lines using single end data," IEEE Trans. Power Del., vol. 18, no. 4, pp. 1166–1173, Oct. 2003.
[5]. C. E. M. Pereira and L. C. Zanetta, Jr., "Fault location in transmission lines using one-terminal postfault voltage data," IEEE Trans. Power Del., vol. 19, no. 2, pp. 570–575, Apr. 2004.
[6]. M. Kezunovic and B. Perunicic, "Automated transmission line fault analysis using synchronized sampling at two ends," IEEE Trans. Power Syst., vol. 11, no. 1, pp. 441–447, Feb. 1996.
[7]. A. L. Dalcastagnê, S. N. Filho, H. H. Zürn, and R. Seara, "An iterative two-terminal fault-location method based on unsynchronized phasors," IEEE Trans. Power Del., vol. 23, no. 4, pp. 2318–2329, Oct. 2008.
[8]. Y. Liao and N. Kang, "Fault-location algorithms without utilizing line parameters based on the distributed parameter line model," IEEE Trans. Power Del., vol. 24, no. 2, pp. 579–584, Apr. 2009.
[9]. J. Izykowski, E. Rosolowski, P. Balcerek, M. Fulczyk, and M. M. Saha, "Accurate noniterative fault location algorithm utilizing two-end unsynchronized measurements," IEEE Trans. Power Del., vol. 25, no. 1, pp. 72–80, Jan. 2010.
[10]. G. Joga Rao, "Power Quality Improvement in Grid Connected Wind Energy System Using STATCOM", International Journal of Scientific Research in Science, Engineering and Technology(IJSRSET)
[11]. G.Joga Rao , T.Santosh Kumar AR Management to Improve Maximum Loading in Standard IEEE 30 Bus System and Allocation of STATCOM", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET)
[12]. Dr. G. Joga Rao, S. Sharmilla, Analysis of Underground Cable Fault Distance Locator, International Journal of Scientific Research in Science, Engineering and Technology (ijsrset.com).
[13]. C. A. Apostolopoulos and G. N. Korres, "A novel algorithm for locating faults on transposed/untransposed transmission lines without utilizing line parameters," IEEE Trans. Power Del., vol. 25, no. 4, pp. 2328–2338, Oct. 2010

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