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# SDFT Based Fault Detection Technique on Distribution System in a Smartgrid with Distributed Generation Sources

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**ABSTRACT:**An accurate method for fault distance calculation in electrical power distribution systems in a Smartgrid with Distributed Generation (DG) sources is proposed. Distribution line faults affect the reliability of the service to the customer, the stability of the power system and the quality of the power delivered. The reason to develop new method is a precise estimation of the fault location, which makes an easier task for maintenance person.

A wide spectrum of signals that contains information about the fault distance is produced when a fault occurs. Synchronized voltage and current samples at sending & receiving ends of a protected zone are used to estimate the location of the fault. This paper proposes Smart Discrete Fourier Transform, SDFT to extract accurate fundamental frequency components for calculation of fault location index. Results have shown that the SDFT based method can extract exact phasor in the presence of frequency deviation and harmonics. The simulations are carried out using MATLAB software. Results of simulation for different types of faults show accuracy of the proposed method.

**KEYWORDS:**Distributed Generation (DG), Smart Grid, Microgrid, Smart Discrete Fourier Transform (SDFT), Distribution System, Phasor Measurement Unit (PMU) and Fault Analysis.

### I. INTRODUCTION

Electric power distribution systems are subjected to faults caused by different reasons like foul weather conditions, insulation failure, traffic accidents, etc [9]. To improve the service reliability, it is necessary for the utility to identify the fault location as quickly as possible when a fault is incident on the distribution network. Most of the research mentioned above focuses on the fault location of the transmission lines. It is because transmission networks are generally under the balanced operation that enables the circuit analysis based on the symmetrical component. The sequence component method generates three independent sequence networks only in case of the balanced systems and becomes a powerful tool in the circuit analysis. However, it cannot be applied to the distribution system case, since most distribution systems are unbalanced due to the mixed use of single phase and three phase laterals and loads, etc. Although a direct circuit analysis of three phase network is another alternative but it has not been considered due to its high complexity and difficulty during the course of analysis. This is why not much research on the fault location problem has been reported for the distribution system. A fast fault location helps in reducing the interruption time, but typical visual examination not only takes an extended time but also additionally needs high work force. Fast restoration of service might reduce complaints, outage time & revenue loss.

Fault location in the distribution system is not an easy task because of its complexity and difficulty resulted by non homogeneity of line, resistance in fault circuit, load uncertainty, and phase unbalance. The basic method to find the fault location with current and voltage measurement is to calculate the impedance using the fundamental components or

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harmonics. Fault location methods for the unbalanced distribution systems utilize harmonics, fundamental component of voltage and current. Fault location methods in distribution systems can be divided into two main categories: impedance based methods and traveling wave based methods. Impedance based methods estimate the Fault location based on the impedance estimation from the fault locator point [25].

Now a days we need reliable & efficient system this can be possible by adding state of the art electronic & electrical devices , parts & algorithms. The base of the system is the decentralization of existing power grid into smaller grid (Microgrid) with Distributed Generation (DG) sources connected. This new system is known as “Smart Grid”. One critical problem due to these integrations is excessive increase in fault current due to the presence of DG within a microgrid [17]. In a smartgrid grid network is decentralized into smaller grids, which are called as microgrids, with DG sources connected to them. These microgrids may or may not be connected with conventional power grid, but the need to integrate various kinds of DGs and loads with safety should be satisfied. Excessive increase in fault current and the islanding are two major challenging issues in direct connection of DGs with the power grid which is caused when, despite a fault in the power grid, DG keeps on providing power to fault state network [19].To address these issues the design of such grid will be based on inter-disciplinary knowledge in the area of communication engineering, optimization, control, social and environmental constraints.[13]. Figure 1 shows significant functional elements of smart grid design.

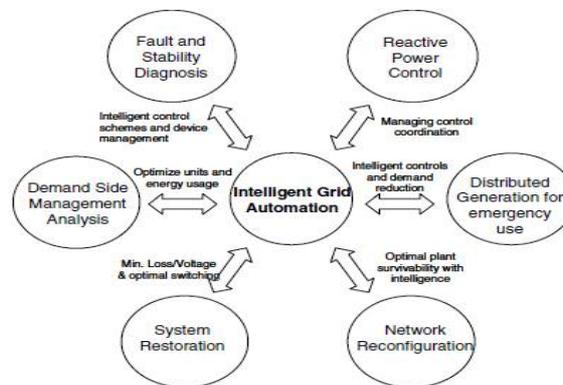


Fig. 1. Smart Grid Intelligent automation functions [13].

In power systems, phasors are used for analyzing AC quantities with the assumption that frequency is constant. A relatively new variant of this technique that synchronizes the calculation of a phasor to absolute time has been developed, called “Synchronized Phasor Measurement” or “Synchrophasor”. Recent Development in Microprocessor based relays, Global Positioning System (GPS) receivers for synchronization as well as exact time stamping, assist in modern relay systems with synchronized measurements, known as ‘synchrophasor measurements’. This Synchrophasor measurements with the help of modern communication provide users the state of a power system 20 times each second.

An accurate on-line fault location for smart distribution system using phasor measurement unit (PMU) is proposed using discrete Fourier transform (DFT) as computation algorithm that is used generally for harmonic analysis. However, because of the leakage effect, poor accuracy, and low speed DFT suffers from specific restrictions due to presence of noise (unwanted Signals) and harmonics. The implementation of a recursive DFT-based filter is economical. However, its performance are often detrimentally affected by decaying DC components, resulting in incorrect estimates. The filtering capability of a DFT-based filter depends on its window length. A short data window will give a fast response but its output will be unstable. To meet the real time use Smart Discrete Fourier Transform

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(SDFT) digital algorithm is presented, it can give accurate solution even when frequency deviates from nominal frequency. It is faster than DFT, and it can give exact solution in the presence of harmonics. In this paper, proposed a SDFT method for estimation of real time and accurate the power system frequency. Simulation results confirm the validity and efficiency of the SDFT method to achieve real time estimation of the power system frequency [16].

## II. RELATED WORK

Guidelines towards the techniques and application considerations for determining the location of a fault on ac transmission and distribution lines are outlined in IEEE Standard IEEE Std C37.114<sup>TM</sup>-2014 (Revision of IEEE Std C37.114-2004),[1].Several investigations have examined the fault detection and location in transmission and distribution lines. Among these investigations Joe-Air Jiang *et al* [2],[8] uses parameter estimation algorithm and SDFT method to determine a fault detection/location index in terms of Clarke components of synchronized phasor measurements. Seung-Jae Lee *et al* [9] proposed fault location algorithm which identifies fault locations using an iterative estimation of load current and fault current at each line section. The diagnosis part determines the actual location by comparing the current waveform pattern with the expected pattern due to operation of the protective devices. Myeon-Song Choi *et al* [11] uses application of the matrix inverse lemma to simplify fault location algorithm based on the direct circuit analysis for unbalance distribution system. Wang, Lui *et al* [15] discuss a fault location method for new protection scheme of distribution system in which faulted section was identified with loading conditions considered in an iterative manner. After the faulted section was identified, fault location was calculated from the voltage equality condition. Jun-Zhe Yang *et al*. [16] proposed Smart Discrete Fourier Transforms (SDFT) to estimate the frequency of a sinusoid with harmonics in real-time. It avoids the errors that arise when frequency deviates from the nominal frequency and keeps all the advantages of the DFT e.g., immune to harmonics and the recursive computing can be used in SDFT. Javad Sadeh *et al*. [25] proposed technique for fault location in distribution systems based on the frequency spectrum components of fault generated traveling waves.

## III. SMART DISCRETE FOURIER TRANSFORM (SDFT)

A sinusoidal input signal with angular frequency  $w = 2\pi f$

Can be represented by,  $x(t) = X \cos (wt + \phi)$  (1)

Where, X : voltage or current signal amplitude

$\phi$  : voltage or current signal phase angle in radian.

Sample set  $\{x(k)\}$  is produced if  $x(t)$  is sampled at a sampling rate (50N) Hz waveform.

$$x(k) = X \cos \left( w \frac{k}{50N} + \phi \right)$$
 (2)

Where,  $k = 0, 1, 2, \dots, N-1$ .

$\bar{x}$  is a phasor representation of signal  $x(t)$  [16],

$$\bar{x} = X e^{j\phi} = X \cos \phi + j X \sin \phi$$
 (3)

Then  $x(t)$  can be represented as [16],

$$x(t) = \frac{\bar{x} e^{j\omega t} + \bar{x}^* e^{-j\omega t}}{2}$$
 (4)

Where, \* denotes complex conjugate

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Moreover, the fundamental frequency (50 Hz) component of DFT of  $\{x(k)\}$  is given by [16]

$$\widehat{x}_r = \frac{2}{N} \sum_{k=0}^{N-1} x(k+r) e^{-j \frac{2\pi k}{N}} \quad (5)$$

Combining equation (4) and (5) and taking frequency deviation ( $w = 2\pi(50 + \Delta f)$ ) into consideration, we get [16]

$$\widehat{x}_r = \frac{\bar{x} \sin \frac{N\theta_1}{2}}{N \sin \frac{\theta_1}{2}} e^{j \frac{\pi}{50N} (\Delta f(2r+N-1)+100r)} + \frac{\bar{x}^* \sin \frac{N\theta_2}{2}}{N \sin \frac{\theta_2}{2}} e^{-j \frac{\pi}{50N} (\Delta f(2r+N-1)+100(r+N-1))} \quad (6)$$

Where,  $\theta_1 = \frac{2\pi\Delta f}{50N}$  and  $\theta_2 = \frac{2\pi(2+\frac{\Delta f}{50})}{N}$

If we define  $A_r$  and  $B_r$  as,

$$\overline{A}_r = \frac{\bar{x} \sin \frac{N\theta_1}{2}}{N \sin \frac{\theta_1}{2}} e^{j \frac{\pi}{50N} (\Delta f(2r+N-1)+100r)} \quad (7)$$

$$\overline{B}_r = \frac{\bar{x}^* \sin \frac{N\theta_2}{2}}{N \sin \frac{\theta_2}{2}} e^{-j \frac{\pi}{50N} (\Delta f(2r+N-1)+100(r+N-1))} \quad (8)$$

Equation (6) can be rewritten as,

$$\widehat{x}_r = \overline{A}_r + \overline{B}_r \quad (9)$$

DFT has an advantage of recursive computing. The frequency deviation In DFT is small enough to be ignored, i.e.  $\widehat{x}_r \approx \overline{A}_r$ . Therefore [16],

$$\phi_r = \arctan(\text{imag}(\widehat{x}_r)/\text{real}(\widehat{x}_r)) \quad (10)$$

$$f = 50 + \frac{\phi_r - \phi_{r-1}}{2\pi} \times 50N \quad (11)$$

The first half of the algorithm of SDFT and standard DFT is the same. So SDFT has all the advantages of DFT. Conventional DFT methods are associated with errors in the estimated frequency and phasor when the frequency deviates from the nominal frequency (50 Hz). In the SDFT taking  $\overline{B}_r$  into consideration the errors are minimised. So defining [16],

$$a = e^{j(\frac{\pi}{50N}(2\Delta f+100))} \quad (12)$$

From equation (7) and (8), we will find the following relations, [16]

$$A_{r+1} = A_r * a \quad (13)$$

$$B_{r+1} = B_r * a^{-1} \quad (14)$$

$$\widehat{x}_{r+1} = A_{r+1} + B_{r+1} = A_r * a + B_r * a^{-1} \quad (15)$$

$$\widehat{x}_{r+2} = A_{r+2} + B_{r+2} = A_{r+1} * a + B_{r+1} * a^{-1}$$

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$$= A_r * a^2 + B_r * a^{-2} \tag{16}$$

There are three unknown variables in equation (9), (15) and (16), therefore after some algebraic simplifications we obtain [16],

$$\hat{x}_{r+1} * a^2 - (\hat{x}_r + \hat{x}_{r+2}) * a + \hat{x}_{r+1} = 0 \tag{17}$$

Solving equation (17), we obtain

$$a = \frac{(\hat{x}_r + \hat{x}_{r+2}) \pm \sqrt{(\hat{x}_r + \hat{x}_{r+2})^2 - 4\hat{x}_{r+1}^2}}{2\hat{x}_{r+1}}$$

Then from “a” in equation (12), we get the exact solution of frequency [16],

$$f = 50 + \Delta f = \cos^{-1}(Re(a)) * \frac{50}{2\pi} \tag{18}$$

Moreover, we can estimate phasor after getting exact “f” by following equations [16],

$$A_r = \frac{\hat{x}_{r+1} * a - \hat{x}_r}{a^2 - 1} \tag{19}$$

$$X = abs(A_r) * \frac{N * \sin(\frac{\pi \Delta f}{50N})}{\sin(\frac{\pi \Delta f}{50})} \tag{20}$$

$$\phi = angle(A_r) - \frac{\pi}{50N} * (\Delta f * (N - 1)) \tag{21}$$

It is observed that SDFT can provide exact frequency and phasor using  $\hat{x}_r, \hat{x}_{r+1}$  and  $\hat{x}_{r+2}$  in the presence of frequency deviation.

By considering harmonics. Assume a sinusoidal signal of frequency  $w = 2\pi f$  with  $m^{th}$  harmonic given by [16],

$$x(t) = X_1 \cos(wt + \phi_1) + X_2 \cos(mwt + \phi_2) \tag{22}$$

Where,  $X_1, X_2$  : Voltage or current signal amplitude

$\phi_1, \phi_2$ : Voltage or current signal phase angle in radian.

Following similar steps developed previously, we can get [16],

$$\begin{aligned} \hat{x}_r = & \frac{\bar{x}}{N} e^{j \frac{2\pi}{N} (1 + \frac{\Delta f}{50}) r} \sum_{k=0}^{N-1} e^{j 2\pi (\frac{\Delta f}{50N}) k} + \frac{\bar{x}^*}{N} e^{-j \frac{2\pi}{N} (1 + \frac{\Delta f}{50}) r} \sum_{k=0}^{N-1} e^{-j 2\pi (\frac{2 + \frac{\Delta f}{50}}{N}) k} \\ & + \frac{\bar{x}}{N} e^{j \frac{2\pi}{N} (1 + \frac{\Delta f}{50}) mr} \sum_{k=0}^{N-1} e^{j 2\pi (\frac{(m-1) + \frac{m\Delta f}{50}}{N}) k} + \frac{\bar{x}^*}{N} e^{-j \frac{2\pi}{N} (1 + \frac{\Delta f}{50}) mr} \sum_{k=0}^{N-1} e^{-j 2\pi (\frac{-1 - m + \frac{m\Delta f}{50}}{N}) k} \end{aligned} \tag{23}$$

Then,

$$\hat{x}_r = \frac{\bar{x}_1 \sin \frac{N\theta_1}{2}}{N \sin \frac{\theta_1}{2}} e^{j \frac{\pi}{50N} (\Delta f (2r + N - 1) + 100r)} + \frac{\bar{x}_1^* \sin \frac{N\theta_2}{2}}{N \sin \frac{\theta_2}{2}} e^{-j \frac{\pi}{50N} (\Delta f (2r + N - 1) + 100(r + N - 1))}$$

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$$+ \frac{\bar{x}_2}{N} \frac{\sin \frac{N\theta_3}{2}}{\sin \frac{\theta_3}{2}} e^{j \frac{\pi}{50N} (m\Delta f(2r+N-1) + 50(2mr+mN-m-N+1))} + \frac{\bar{x}_2^*}{N} \frac{\sin \frac{N\theta_4}{2}}{\sin \frac{\theta_4}{2}} e^{-j \frac{\pi}{50N} (m\Delta f(2r+N-1) + 50(2mr+mN-m-N+1))} \quad (24)$$

$$\hat{x}_r = A_r + B_r + C_r + D_r \quad (25)$$

$$\begin{aligned} \hat{x}_{r+1} &= A_{r+1} + B_{r+1} + C_{r+1} + D_{r+1} \\ &= A_r * a + B_r * a^{-1} + C_r * a^m + D_r * a^{-m} \end{aligned} \quad (26)$$

Where,

$$C_r = \frac{\bar{x}_2}{N} \frac{\sin \frac{N\theta_3}{2}}{\sin \frac{\theta_3}{2}} e^{j \frac{\pi}{50N} (m\Delta f(2r+N-1) + 50(2mr+mN-m-N+1))}$$

$$D_r = \frac{\bar{x}_2}{N} \frac{\sin \frac{N\theta_4}{2}}{\sin \frac{\theta_4}{2}} e^{j \frac{\pi}{50N} (\Delta f(2mr+N-1) + 50(2mr+mN-m-N-1))}$$

$$\theta_3 = \frac{2\pi(m-1 + \frac{m\Delta f}{50})}{N}$$

$$\theta_4 = \frac{2\pi(-m-1 + \frac{m\Delta f}{50})}{N}$$

We need five equations to get the answer as there are five unknown variables in Equation (25); So using  $\hat{x}_r$ ,  $\hat{x}_{r+1}$ ,  $\hat{x}_{r+2}$ ,  $\hat{x}_{r+3}$  and  $\hat{x}_{r+4}$ , we can get exact frequency and phasor in the presence of one harmonic [16].

### IV. THE PROPOSED FAULT DETECTION TECHNIQUE

The SDFT-based method and fault location index are combined with a PMU configuration to create an adaptive fault locator system shown in Fig. 2. A SDFT algorithm in the PMUs is used to process the data measured at both ends. To check the performance, we used the synchronized sampled data (voltages and currents) from respective ends. To extract fundamental phasors for calculating the index SDFT method is applied. This method has ability to locate the fault of transmission and distribution line. The recursive nature of SDFT makes it suitable for the online monitoring applications [6].

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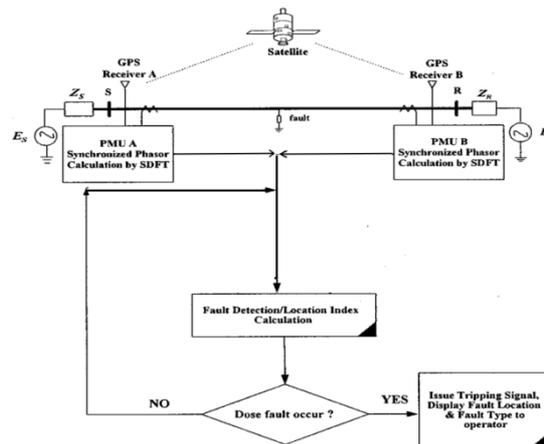


Fig. 2. Configuration of adaptive PMU based fault location system [2,4].

Fig. 3 shows a single-circuit transposed transmission line. Total line length is  $L$ , and  $V_s, V_R$  are synchronized voltage phasor and  $I_s, I_R$  are synchronized the current phasor measured on buses S and R respectively. Symmetrical component transformation is used to decouple three-phase quantities. and to consider only the variation of a distance variable (km), from bus R at a distance  $x$  the relation between the voltages and currents can be expressed by the following sequence equations,

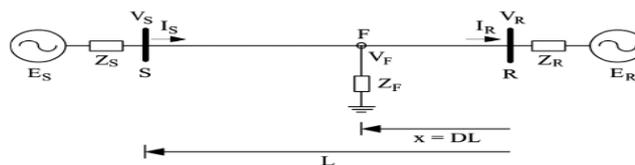


Fig.3. One line view of a single circuit transposed transmission line with a fault at a distance  $x = DL$  away from the bus R [6].

$$\frac{dV}{dx} = Z I \tag{27}$$

$$\frac{dI}{dx} = Y V \tag{28}$$

where  $Z$  is per-unit length sequence impedance (ohm/km) and  $Y$  is admittance (mho/km) of the transmission line. The matrices of  $Z$  is diagonal matrices with  $(Z_0, Z_1, Z_2)$  and  $Y$  is diagonal matrices with  $(Y_0, Y_1, Y_2)$  diagonal elements respectively. The zero, positive and negative sequence variables are denoted by the subscripts 0, 1, and 2, respectively.

The solutions of the voltages and currents of the three decoupled sequence systems can be written as

$$V_{xi} = [ A_i \exp(\tau_i x) + B_i \exp(-\tau_i x) ] \tag{29}$$

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$$I_{xi} = \frac{1}{Z_{Ci}} [ A_i \exp(\tau_i x) - B_i \exp(-\tau_i x) ] \quad (30)$$

Where,  $Z_{Ci} = \sqrt{\frac{Z_i}{Y_i}}$  denotes the characteristic impedance, and  $\tau_i = \sqrt{Z_i Y_i}$  is the propagation constant. The constants  $A_i$  and  $B_i$  can be obtained from the boundary conditions of the voltages and currents measured at bus R and bus S, respectively. Therefore, the voltages (Equation 29) can be further rewritten as

$$V_{xi,R} = \frac{(V_{xi,R} + Z_{Ci} I_{i,R})}{2} e^{\tau_i x} + \frac{(V_{xi,R} - Z_{Ci} I_{i,R})}{2} e^{-\tau_i x} \quad (31)$$

$$V_{xi,S} = \frac{1}{2} e^{-\tau_i L} (V_{i,S} + Z_{Ci} I_{i,S}) e^{\tau_i x} + \frac{1}{2} e^{\tau_i L} (V_{i,S} - Z_{Ci} I_{i,S}) e^{-\tau_i x} \quad (32)$$

Equations (31) and (32) correspond to voltages at point x, which are expressed in terms of the two data sets  $(V_{i,R}, I_{i,R})$  and  $(V_{i,S}, I_{i,S})$  measured at the receiving end, R, and sending end, S, of the line, respectively

Assume a fault is occur at point F, at a distance  $x = DL$  km from the receiving end, R, on a Distribution line (Fig. 3), where D is termed the per-unit fault location index. By Using  $V_{F,R} = V_{F,S}$  and equating  $V_{xi,R}$  to  $V_{xi,S}$  (equations 31 and 32), the index can be solved as

$$D = \frac{\ln\left(\frac{N}{M}\right)}{2\tau L} \quad (33)$$

Where M and N are given by,

$$M = \frac{1}{2} (V_S + Z_C I_S) e^{-\tau L} - \frac{1}{2} (V_R + Z_C I_R) \quad (34)$$

$$N = \frac{1}{2} (V_R - Z_C I_R) - \frac{1}{2} (V_R - Z_C I_S) e^{\tau L} \quad (35)$$

The Calculated value of D is between 0 and 1 when fault is in between bus R and S. when fault is outside the protected zone the value of D is indefinite. There is no effect of variations in the fault impedance, source impedance, and fault type on index D.

Percentage error is calculated as [6]

$$\text{Error}(\%) = \frac{|\text{Estimated location in km} - \text{actual location in km}|}{\text{Total line length in km}} \times 100 \quad (36)$$

### V. POWER SYSTEM SIMULATION MODEL

Fig. 4 shows a newly developed Simulink / SimPowerSystem microgrid model is designed by connecting a 10 MVA wind farm and a 200 kW solar farm with the distribution network. The simulated power system consist a 100 MVA conventional power plant, a three-phase synchronous machine, connected through a step-up transformer, TR1 to a 200 km long 154 kV distributed-parameter transmission line. The voltage is stepped down from 154 kV to 22.9 kV at the substation (TR2). Separate distribution-branch networks is used to supply industrial load of 6 MW and domestic loads (1 MW each). To the branch network (B1) at bus B3 the wind farm is connected through transformer TR3, and the solar farm with maximum power point tracking MPPT is connected at bus B4 through transformer TR7, providing power to the domestic loads. Five 2 MVA fixed-speed induction-type wind turbines are used for 10 MVA wind farm. [17, 19].

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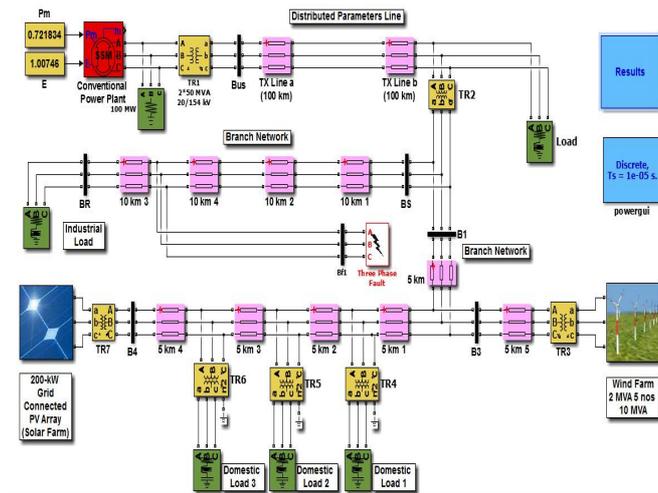


Fig. 4: Smartgrid model with DG sources in MATLAB / Simulink with SDFT based PMU for locating fault in distribution system. [ 19]

## VI. SIMULATION RESULTS

The system described in the foregoing was simulated in healthy fault-free condition with DG sources and then with different faults in the distribution system at different distances. The waveforms observed with a severe fault like a three-phase short circuit for three-phase voltage, current and power are shown in Fig.5 to Fig. 10.

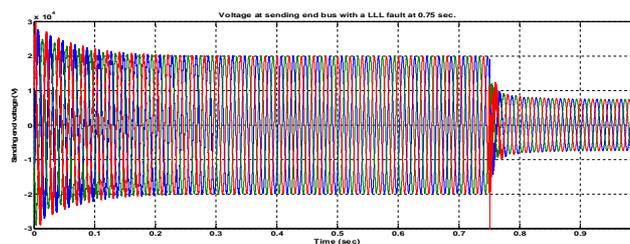


Fig. 5: 3- $\Phi$  sending end voltage in primary distribution circuit (V) at 22.9 kV bus BS with a LLL fault at 0.75 sec.

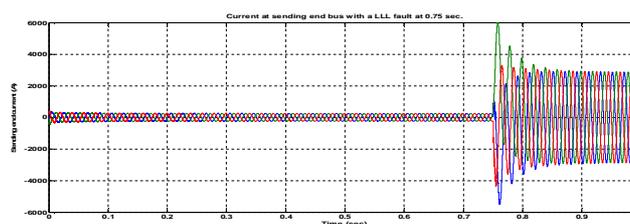


Fig. 6: 3- $\Phi$  sending end current in primary distribution circuit (A) at 22.9 kV bus BS with a LLL fault at 0.75 sec.

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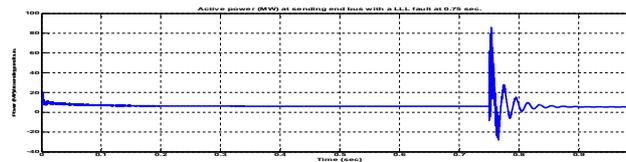


Fig. 7: 3- $\Phi$  sending end active power in primary distribution circuit (MW) at 22.9 kV bus BS with a LLL fault at 0.75 sec.

The figure 5 -7 shows the sending end voltage, current & active power. When the fault will appear at 0.75 Sec. The system voltage drastically reduces & sending end current will increase because of decrease in system impedance. That will result in sudden change in the active power in system. A fault will produces oscillation in the system which can be easily observed from the waveform.

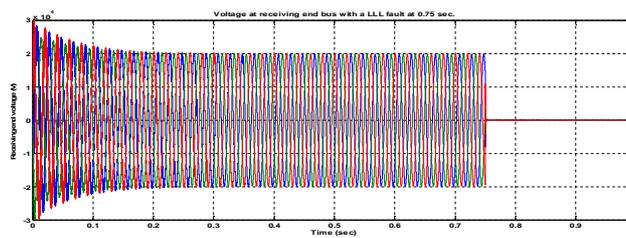


Fig. 8: 3- $\Phi$  receiving end voltage in primary distribution circuit (V) at 22.9 kV bus BR with a LLL fault at 0.75 sec.

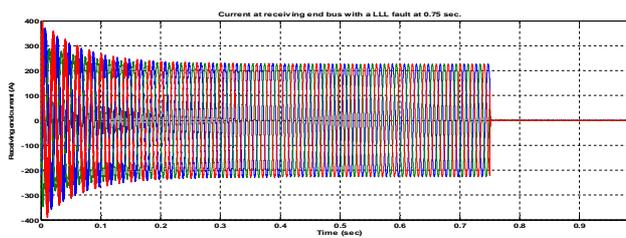


Fig. 9: 3- $\Phi$  receiving end current in primary distribution circuit (A) at 22.9 kV bus BR with a LLL fault at 0.75 sec.

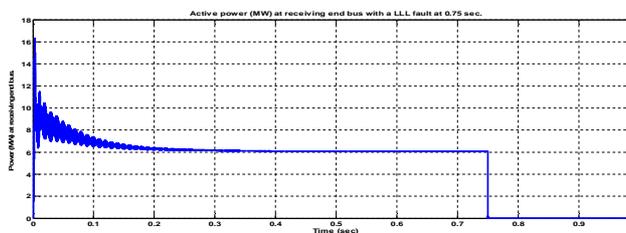


Fig. 10: 3- $\Phi$  receiving end power in primary distribution circuit (MW) at 22.9 kV bus BR with a LLL fault at 0.75 sec.

The figure 8 -10 shows the receiving end voltage, current & active power. When the fault will appear at 0.75 Sec. The receiving end voltage and current is nearly equal to zero as the fault will provide low impedance path for the flow of current. The active power in system at receiving end is nearly zero.

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With Smart Discrete Fourier Transform (SDFT) we get voltage and current phasors. For line-to-ground fault the fault resistance of  $0.001 \Omega$  is assumed for every 10 kms length on the line. The proposed method is applied to each case. Table 1 shows the results of simulation with estimation error defined as given in Eq. 36 for symmetrical & unsymmetrical fault like Three phase fault (LLL), Three phase to ground (LLLG), Double line to ground (LLG) and Line to ground fault (LG) at different distances. It can be found that the errors range from -9.0280 to 2.2421% and minimum error is - 0.0392 % which is nearly zero, which means the suggested method is quite helpful in fault location problem. Actually, error due to DC offsets is present in finding the phasors of voltage and current.

Table 1: Located distance for different faults at various locations and % location error.

Distance in km	LLL (SC) fault		LLL-G fault		LL-G fault		L-G fault	
	Distance in km	% Error						
0	0.0016	0.004	0.0016	0.004	0.4578	1.144	1.2187	3.046
10	10.4292	1.073	10.4292	1.073	10.0350	0.087	8.4173	-3.956
20	20.8968	2.242	20.8968	2.242	18.5664	-3.583	18.3888	-4.027
30	30.0677	0.169	30.0677	0.169	27.2389	-6.902	28.2690	-4.327
40	39.9855	-0.039	39.9855	-0.039	36.3888	-9.028	38.0674	-4.831

## VII. CONCLUSION

we have proposed an adaptive fault location technique in a smart grid with DG sources. The SDFT method used in this paper. With the advent of these algorithms, the performance of the proposed technique in locating faults in distribution lines has become excellent. As no assumptions are needed to calculate the index. Frequent test of MATLAB simulations has been conducted to get the precise result and to evaluate the performance of the proposed algorithm with various fault events. A special filtering technique called the SDFT method was developed to solve the aforementioned problems. The accurate system frequency and fundamental phasors extraction are verified by using

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this method. It has been observed during simulation results that the more than 90% fault can be located accurately. This technique will be an highly efficient & effective, adaptive, and inexpensive fault location technique.

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