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ISLANDING DETECTION USING DEMODULATION BASED FFT

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Abstract— when the load mismatch occurs, it clearly reveals that there exists an impedance mismatch in power distribution systems. This is a serious problem in power delivery. Hence in this method based on multiple frequency harmonic current injection is injecting two non-characteristic symmetric harmonic currents, and then according to the different harmonic voltages caused by different frequency harmonic currents, all three-phase impedances can be calculated accurately. This project proposes a novel method of Demodulation based FFT for three-phase grid impedance detection method based on dual-frequency harmonic current injection for islanding detection. This method differs from the conventional transform by the way of changing spectrum detection method. The estimation of harmonic content and based on the amount of harmonics islanding is decided. Using Fourier transforms always results in perfect harmonic estimation and hence the islanding also can be detected with our proposed method. Grid impedance detection based on single harmonic current injection is reliable in three-phase impedance balanced grid. Simulation and experiments are carried out under grid impedance balanced and unbalanced conditions.

Keywords- PCC, Grid, DG, DFIG, FFT, PWM

I. INTRODUCTION

As the composition of power systems changes with the increased use of distributed generation (DG), the ability to maintain a secure supply with high power quality is becoming more challenging. The increased use of power electronic converters as part of loading systems could cause further power quality problems: converters act as strong harmonic current (or voltage) sources. The information on power system parameters (particularly the net power system impedance to source) at any instant in time is central to addressing these problems.

For example, power system impedance monitoring is an important enhancement to active filter control. The impedance estimation can be embedded into the normal operation of grid connected power electronic equipment (PEE) such as sinusoidal rectifiers and active shunt filters (ASF). PWM harmonics associated with PEE, as measured in the active filter line current or voltage at the point of common connection (PCC) can provide non-invasive estimation of power system impedance changes, although it is not accurate enough to provide a suitable value for control. A small disturbance introduced by a short modification to the PEE's PWM strategy can be used to excite the power system impedance and the associated voltage and current transients can be used to determine more exactly the supply impedance back to source, Zs. This invasive method is only triggered when the non-invasive method determines a significant change in Zs. The previous estimation strategy required that the PEE line current and PCC line voltage be measured for 160 ms before the transient injection, and 160 ms post-transient in order to get a suitable frequency resolution for the impedance measurement (6.25 Hz). The analysis proposed in this paper would substantially reduce the period for data capturing to 5 ms post transient, and reduce pre-transient data requirement. This is because the Continuous Wavelet Transform (CWT) is used to process voltage and current transients for calculating the supply impedance. The proposed method therefore has the potential to determine the change in the supply impedance within half a supply cycle. This paper introduces the concept of real-time impedance estimation, and then describes how FFT is used to significantly speed up impedance estimation, demonstrating this capability with experimental results. The paper then goes on to describe how this estimation technique may be used to locate faults inside

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and outside a defined power "zone." Fault identification and location is an important application of real-time impedance estimation, and may find use in renewable/distributed energy systems, and power grids for more-electric aircraft and more-electric ships.

II. PROPOSED SYSTEM

The power system impedance to source is measured by injecting a disturbance onto the system at PCC and analyzing the transient response using measured voltages and currents. The disturbance in this case is manufactured by manipulating two successive PWM cycles in the operation of PEE such that they appear to inject a very short disturbance. For this work, PEE is an active shunt filter as illustrated in Fig. 1. The presence of the ASF filter inductance (in Fig. 1) results in a short current spike, of approximately 1 ms long and 20 A peak, injected into PCC as shown in Fig. 2. Previous methods for analyzing data have included the use of a simple Digital Fourier Transform (DFT) on the measured data and the use of Welch's Averaged Period gram Algorithm. In both techniques, 8 cycles of pre-transient measurement data are subtracted from 8 cycles of transient data to compensate for the system fundamental and other harmonics frequencies normally The impedance estimates at harmonic frequencies are discarded and an interpolation routine is used to determine the impedance to source at such frequencies describe how the estimated impedance at 5th, 7th, and 11th harmonic frequencies are used to generate reference signals for ASF. The excellent control of the filter demonstrates how an active shunt filter can operate in standalone or sensorless mode (where sensorless means that ASF does not require an explicit measurement of supply or load currents). In order to calculate power system quantities, one needs to analyze amplitudes and phase differences between the related voltages and currents. Complex wavelet bases are capable of delivering instantaneous amplitudes of voltages and currents as well as instantaneous phase angles. Using this information, alternative system impedance definitions can be found with time and frequency localization properties. In a single-phase system, the complex wavelets transform will yield two series of complex wavelet coefficients for voltage and current. Using these coefficients, instantaneous values of amplitude and phase are derived for different sub-bands.

$$\underline{v}_W(\tau, s) = v_W(\tau, s)\angle\varphi_{v_W}(\tau, s)$$
$$\underline{i}_W(\tau, s) = i_W(\tau, s)\angle\varphi_{i_W}(\tau, s)$$

Using the instantaneous voltage and current amplitude and the instantaneous phase difference between voltage and current, complex wavelet based system impedance is identified as

$$\underline{Z}_W(\tau, s) = \frac{\underline{v}_W(\tau, s)}{\underline{i}_W(\tau, s)}$$

In this case, the system impedance is defined in the wavelet domain. For calculation, a series of impedances are considered at different scales and time, and an average value is estimated over the first half cycle (0.01 second) of the system impedance in the frequency ranges of interest. This can be done by mapping each level of scale to the pseudo-frequency fs as:

$$f_s = \frac{f_c}{S \cdot \Delta t}$$

Where fc is the centre frequency of the wavelet in Hz, is the scale level, and delta t is the sampling period. The averaging of the estimated impedance will smooth the signal without using any particular threshold. Alternatively, taking the local maxima of CWT coefficients at each scale would provide similar results.

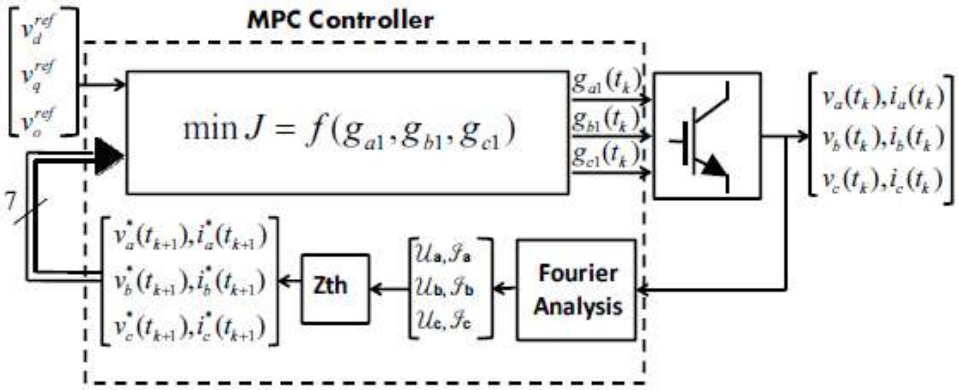


Fig 1. One line diagram of three phase grid

The diagram shown as fault is basically an injection of harmonic voltage and hence the current in specified harmonic order, other than the fundamental order. The proposed islanding estimation technique is evaluated and control action is performed based on breaker disconnection through threshold detection. The impedance measurement is used to identify the proximity of a grid fault to PEE. This measurement is used to decide whether PEE should ride through certain remote faults to avoid nuisance trips. Islanding may also be detected. Consider the system in Fig. 6 in which a small power system is defined to be a "protected zone" in a larger power system. Details of the system parameters, which are based on a medium voltage distribution system, are given in the Appendix. Within the zone there are distributed generation and power electronic equipment for example an active filter, a grid interface for a wind turbine, or photovoltaic system—which are connected at the point of measurement (POM). The grid connection codes state that if a fault is detected usually through the Rate of Change of Frequency.

PROTECTION ZONE

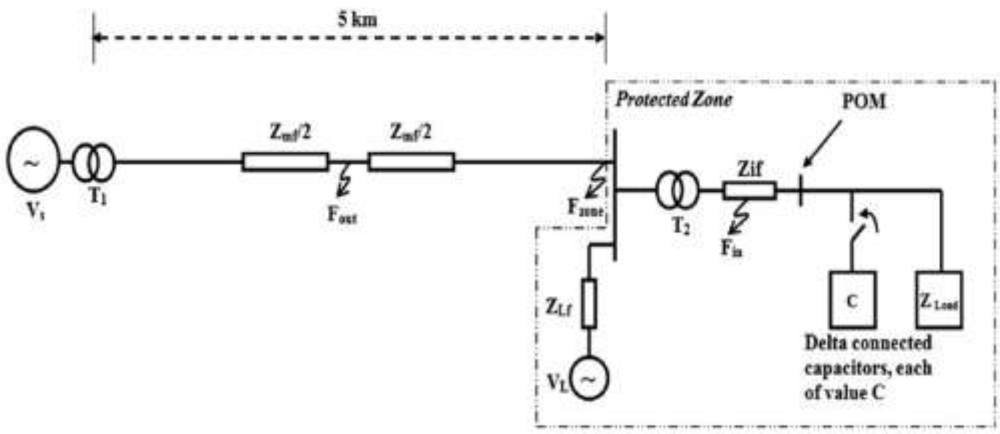


Fig 2. One line circuit diagram of Power grid with impedance

(ROCOF) measurement—the distributed generator must be disabled. However, with the increasing interest in microgrids and other sustainable energy systems, it may be preferable to operate at the presence of certain faults (i.e., those outside the zone) and only shut down the zone if the fault occurs within the zone. It is possible to locate and specify a type of fault using the proposed impedance estimation.

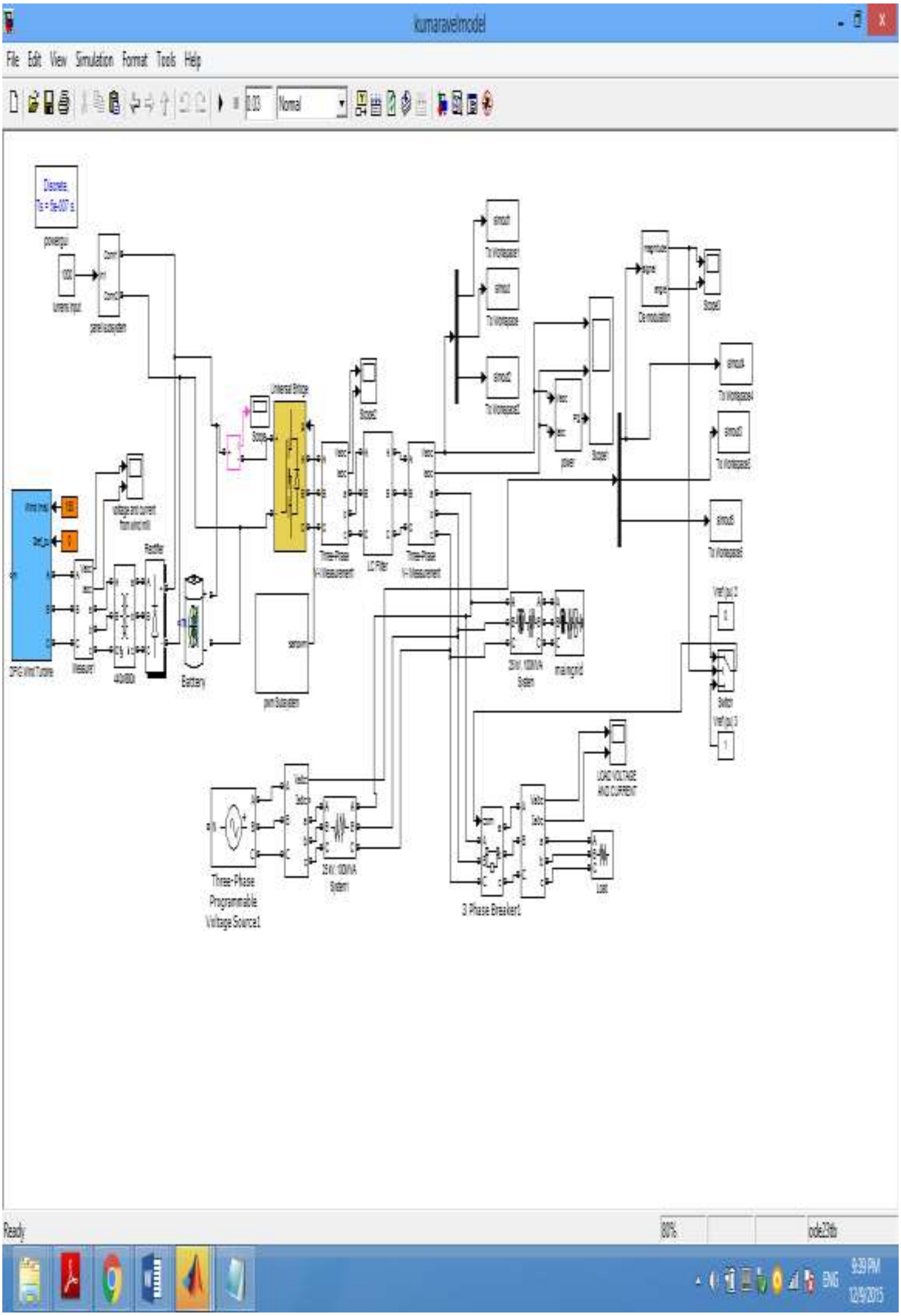
• Fault within the zone corresponding to a single phase short circuit to ground, halfway along the internal feeder.

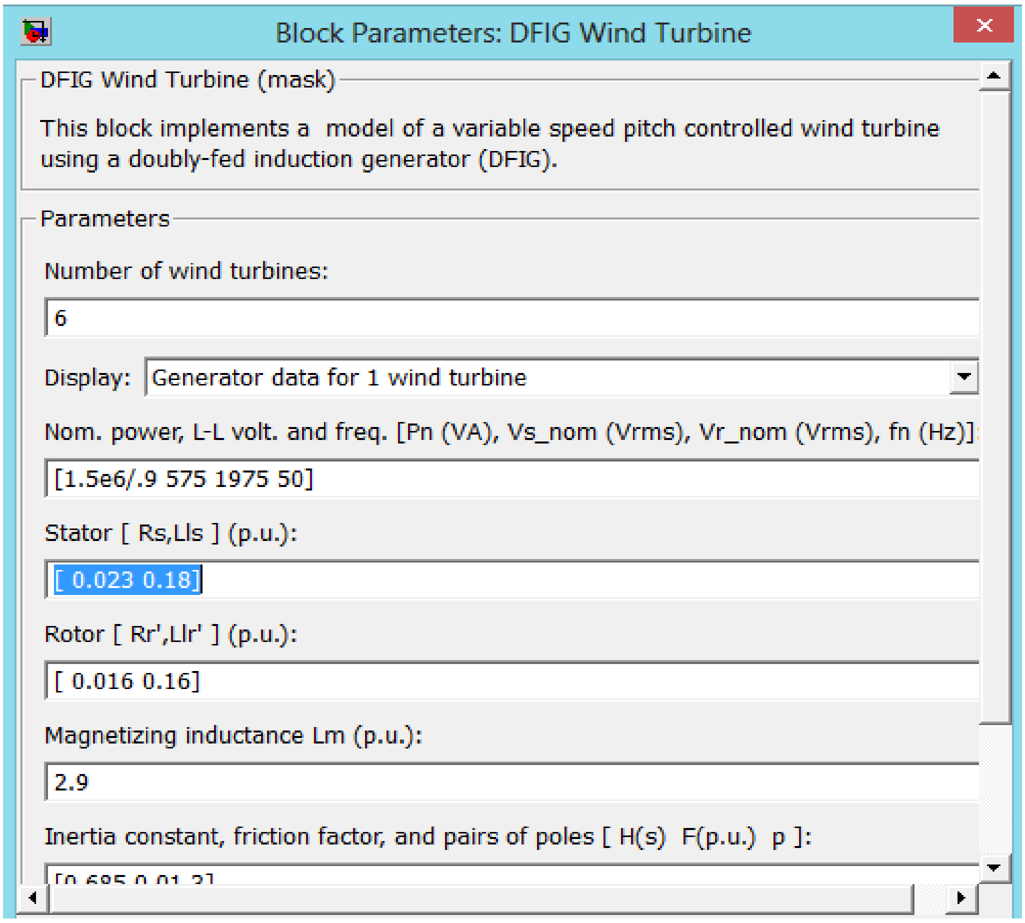
• Fault on the zone boundary corresponding to a single phase short circuit to ground.

• Fault outside the zone corresponding to a short circuit to ground halfway along the main feeder

III. SIMULATION RESULTS

To verify the feasibility of the proposed strategy, simulations are carried out.





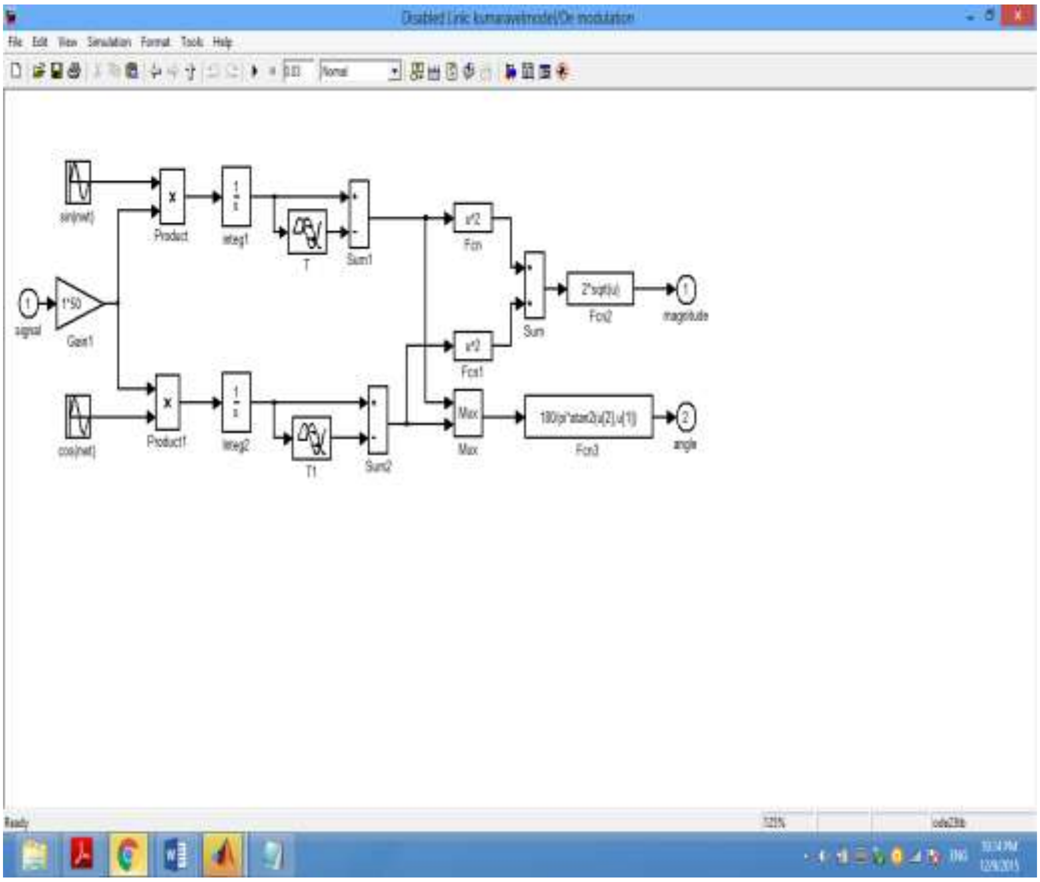


Fig.3. Proposed system Simulink diagram

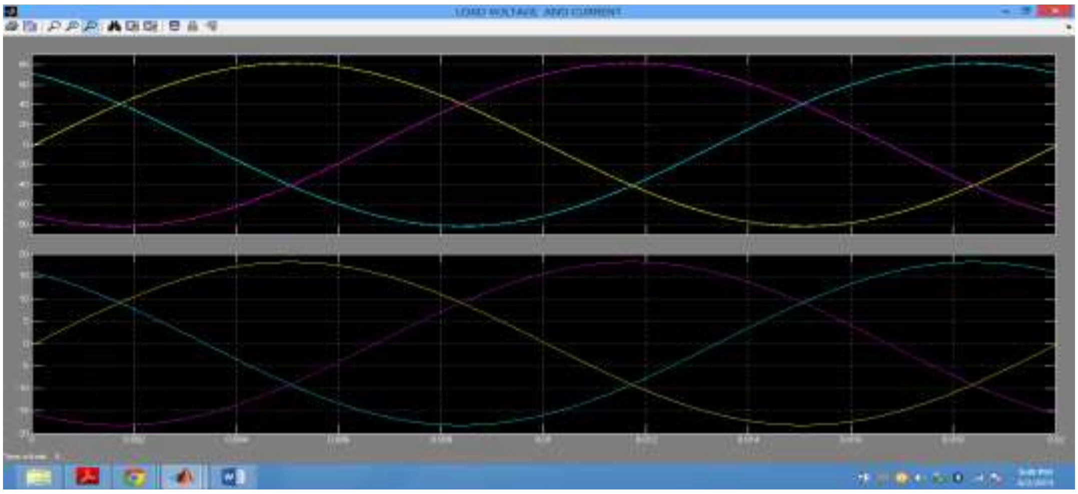


Fig.4. Three phase AC voltage and current

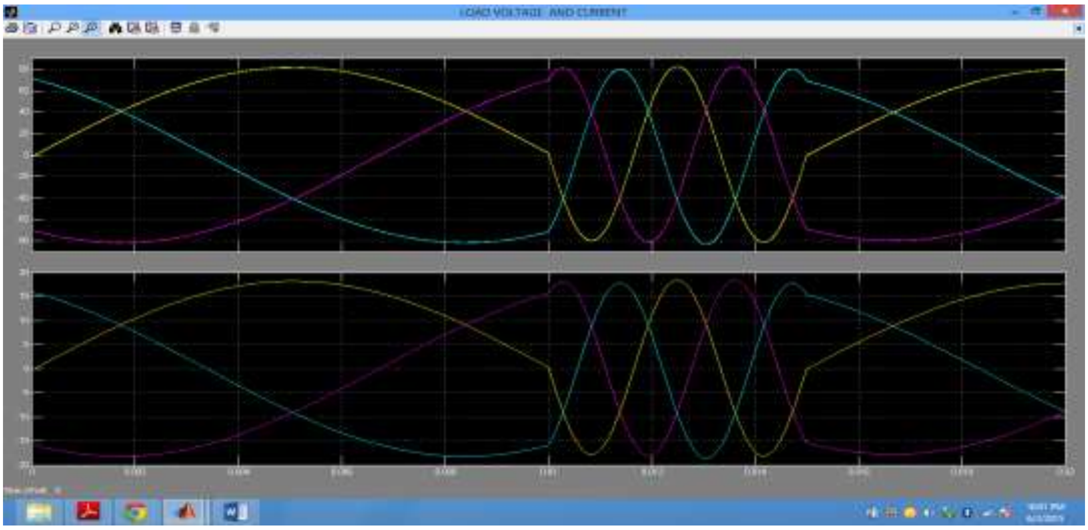


Fig.5. Three phase AC voltage an current with faulty condition

It could be seen that the third harmonic is being injected into the line from the time 0.015 to 0.2 s. This change in frequency has to be detected by the wavelet lifting scheme.

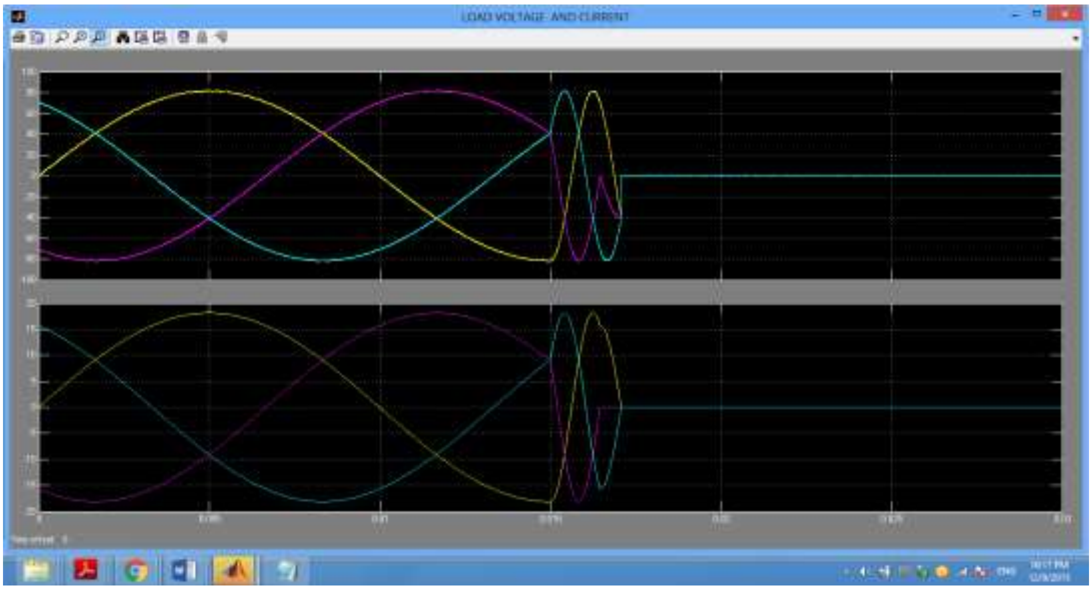


Fig.6. Three phase AC voltage an current with faulty condition after inserting islanding included

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IV. CONCLUSIONS

This project proposed a novel method of FFT based abnormality detection to decide the decision of islanding is needed or not and further control of grid through DCT while using the DC components amplitude. The problem of micro grid is its discontinuity in the power delivery based on the available power. This is a serious problem in power delivery. A Simulink model consisting of a distributed generator and the main power grid based generator is designed and faults are created at random times. In such conditions, islanding is needed to protect the loads, grids and even to maintain the continuity in the power delivery. FFT transform are the peculiar category of frequency domain approaches, frequency abnormality is detected accurately due to the demodulation based harmonic detection. Theoretical analysis and experiment results proved that the proposed method is practically feasible.

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