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Design of Criterion Function for Analysis of Different Faults & Switching Conditions From Over current Using Symmetrical Components

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ABSTRCAT: In electrical system, the irregularities in power are generally occurs, due to transients or faults. Sometimes the transients/ switching are treat as a fault and the circuit gets trip by using different relays. To overcome such problems and get exact fault condition of either switching or fault, the criterion function is introduced in this paper.

The criterion function which is shown by symbol 'R' is formulated from symmetrical components. This methodology is used for accurate result and the model of 13 bus bar system referred from [1], implemented in MATLAB.

KEYWORDS: Analysis, Criterion function, Fault, Over current, Switching, symmetrical components.

I. INTRODUCTION

Power systems are large and complex electrical networks. In Any power system, generations are located at few selected points and loads are distributed throughout the network. In between generations and loads, there exist transmission and distribution systems. In the power system, the system load keeps changing from time to time.

In the existing system, the cause of the equipment failure and malfunction can be determined through a system study. The computational efforts are very much simplified in the present day calculations due to the availability of efficient programs and powerful microcomputers.

Properly designed power system should have the following characteristics:

1. It must supply power, practically everywhere the customer demands.
2. It must supply power to the customers at all times.
3. It must be able to supply the ever changing load demand at all time.
4. The power supplied should be of good quality.
5. The power supplied should be economical.
6. It must satisfy necessary safety requirements.

The development of deregulation in power systems leads to a higher requirement on power quality. In the area of relay protection this means that a faster protection is needed, while undesirable operation of the protection system is almost unacceptable. A faster protection can guarantee that an abnormal operation mode somewhere in a system, such as voltage sag caused by faults, can be quarantined quickly, so as not to propagate to the rest of the system and cause instability. To do this, a relay protection should be sensitive. Unfortunately, high sensitivitysometimescausesundesirableoperationofrelayprotectionwhenthereisnofaultinthesystem.Inaderegulatedpower market this directly leads to penalty compensation to the users that suffer from the blackout [1].

This paper uses the concept of symmetrical components and presents a method for preventing the undesirable relay operations due to over currents following a switching. In this method, a criterion function versus these components is introduced. The proper performance of this function will be studied by simulation of various faults and switching cases (motor starting and transformer energizing) using MATLAB/SIMULINK software. Since the basis of the recommended algorithm is the data obtained from the sampled current, which is taken normally from the over current relays, it prevents the undesirable relay operations with no extra hardware cost.

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II. IMPLEMENTED METHOD

An algorithm based on symmetrical components is proposed to detect and identify the balance condition of the power system during the fault. An expert system is presented here that is able to classify different types of power system events to the underlying causes (*i.e.*, events) and offer useful information in terms of power quality using MATLAB/SIMULINK software that are used to analyze real time distribution system. A MATLAB/GUI based simulation tool has been developed to analyze power system operation [1]. The criterion function 'R' based on concept of symmetrical components presents method for preventing the undesirable relay operation due to over currents following switching. It will give a method for improving over current relay operation. It formulates an algorithm based on different behavior of current components during fault and non-fault conditions. Based on these differences, a criterion function 'R' is introduced, considering undesirable operations of over current relays due to switching is presented in [2].

$$V_{abc} = \begin{bmatrix} V_a \\ V_B \\ V_C \end{bmatrix} \quad (1)$$

Therefore, the three symmetrical components phasors arranged into a vector are as follows:

$$V_{012} = \begin{bmatrix} V_0 \\ V_1 \\ V_2 \end{bmatrix} \quad (2)$$

Where the subscripts 0, 1, and 2 respectively refer to the zero, positive, and negative sequence components. A phase rotation operator 'a' is defined to rotate a phasor vector forward by 120 degrees. Matrix A can be defined using this operator to transform the phase vector into symmetrical components:

$$A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix} (3)$$

The phase voltages are generated by the sequence equation.

$$V_{abc} = AV_{012} \quad (4)$$

Conversely, the sequence components are generated from the analysis equations.

$$V_{012} = A^{-1}V_{abc} \quad (5)$$

Where:

$$A^{-1} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & a & a^2 \\ 1 & a^2 & a \end{bmatrix} (6)$$

When transformer is switched, inrush current will happen. This current has some features, which it is enough to identify itself. In this paper, to extract these features, a new criterion is proposed to discriminate inrush currents from internal faults in power transformers. The point is the value of negative sequence is different from positive sequence in faulty conditions. Helping this rule, the criterion is introduced:

$$\begin{bmatrix} I_0 \\ I_1 \\ I_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \propto & \propto^2 \\ 1 & \propto^2 & \propto \end{bmatrix} \quad (7)$$

$$\propto = \propto \angle 120 \Longrightarrow \mathrm{I_a} = 1\angle 0, \mathrm{I_b} = 1\angle + 120, \mathrm{I_c} = 1\angle - 120 \quad (8)$$

In faulty condition, it is obvious that the value of I_2 (negative current) is larger than I_1 (positive current) in normal condition. Using this feature, define new below criterion:

$$\mathrm{R} = \frac{|\mathrm{I_1}| - |\mathrm{I_2}|}{|\mathrm{I_1}| + |\mathrm{I_2}|} \quad (9)$$

III. SWITCHING EFFECTS

The effect of switching on relay occurs in case of transformer and motor is discussed below:

1) Transformer Switching:

The inrush current contains both odd and even order harmonics. Although digital relay's filter is used to extract the fundamental component of the current, the magnitude of the signal may lead to undesirable operation of the relay. Another concern about transformer energizing is transient propagation. This causes considerable amount of even harmonics and dc component in the voltage.

2) Motor switching:

The starting current of a large induction motor is typically five to six times the rated current. In fact, the starting current has a very high initial peak. That value is damped out after a few cycles, normally no more than two cycles depending on the circuit time-constant [3].

IV.CRITERION FUNCTION

Criterion function is the formula considered from the RMS values of currents [5] when the zero sequence components is equal to zero i.e. current I_0=0.

$$R = \frac{|I_1| - |I_2|}{|I_1| + |I_2|}$$

Since there is a considerable negative component in the asymmetrical fault case, according to criterion function the value of 'R' is close to zero. In the switching case, the negative component is very small and 'R' is close to 1. The suggested criterion is independent of the amplitude of the current which is advantageous. The reason is that it operates based on the relative difference between the negative and positive component of the current [4]. Another advantage of the suggested criterion function is that its proper operation is independent of the power system balancing it also operates properly. The reason is that during the asymmetrical fault, the negative component of current increases and the value is much smaller than that before fault event.

R<0.35 indicates the fault; otherwise, overcurrent is the result of switching.

V.IMPLEMENTED MODEL FOR 13 BUS BAR SYSTEM

To show the advantage of the criterion function 'R' for overcurrent protection, a part of a distribution system 34.5 kV 13 bus is shown in Fig. 1, is modeled using the MATLAB/Simulink, also the network parameter of the 13-bus distribution system is shown. Several non-fault events are applied to this system along with unsymmetrical faults i.e., single line to ground, line to line and double line to ground events at different times. The simulation results show, how the proposed algorithm could help the overcurrent relay to discriminate fault from non-fault events [6].

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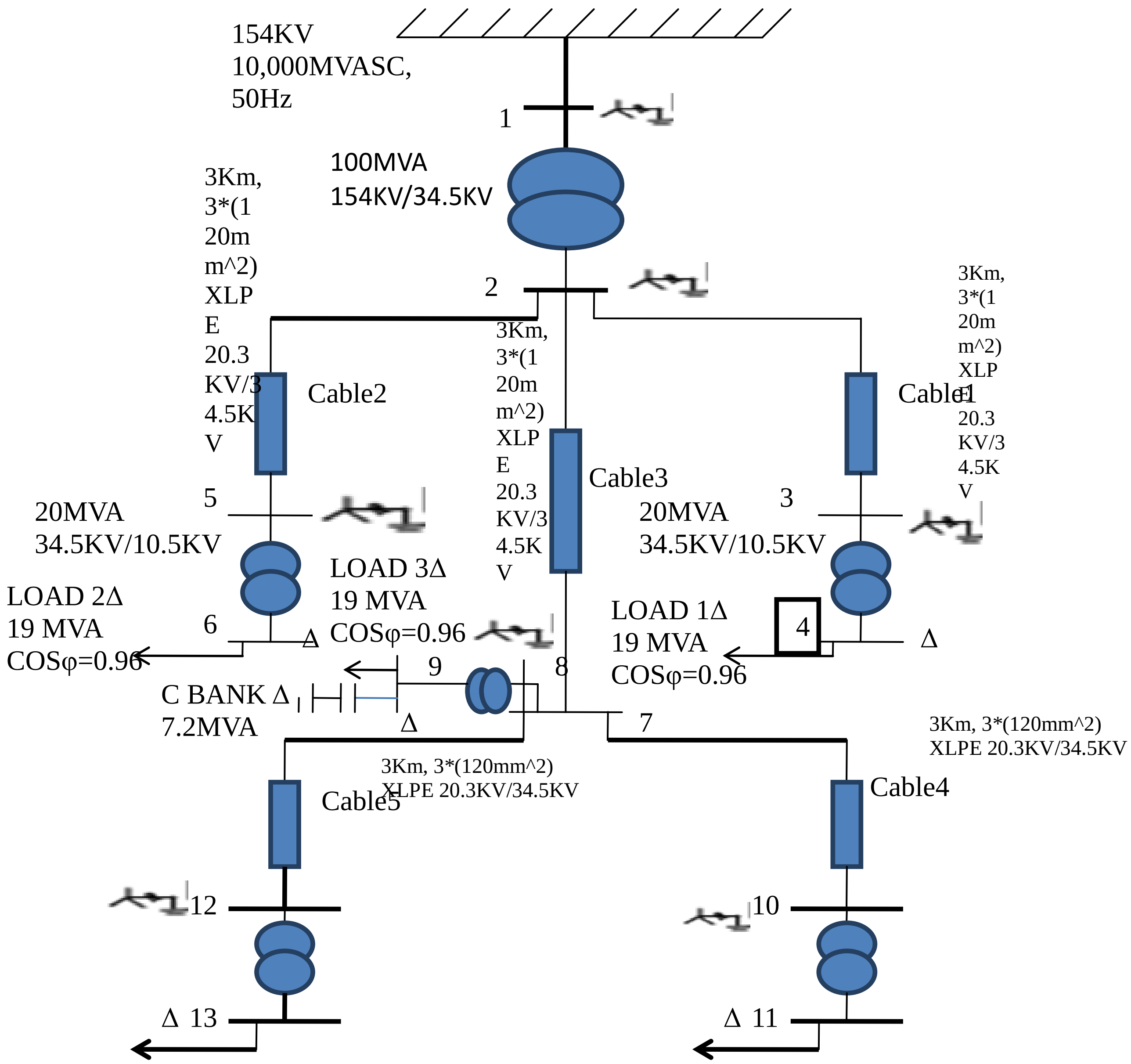

Fig. 1: 13 Bus (34.5 kV Simulated Distribution System)

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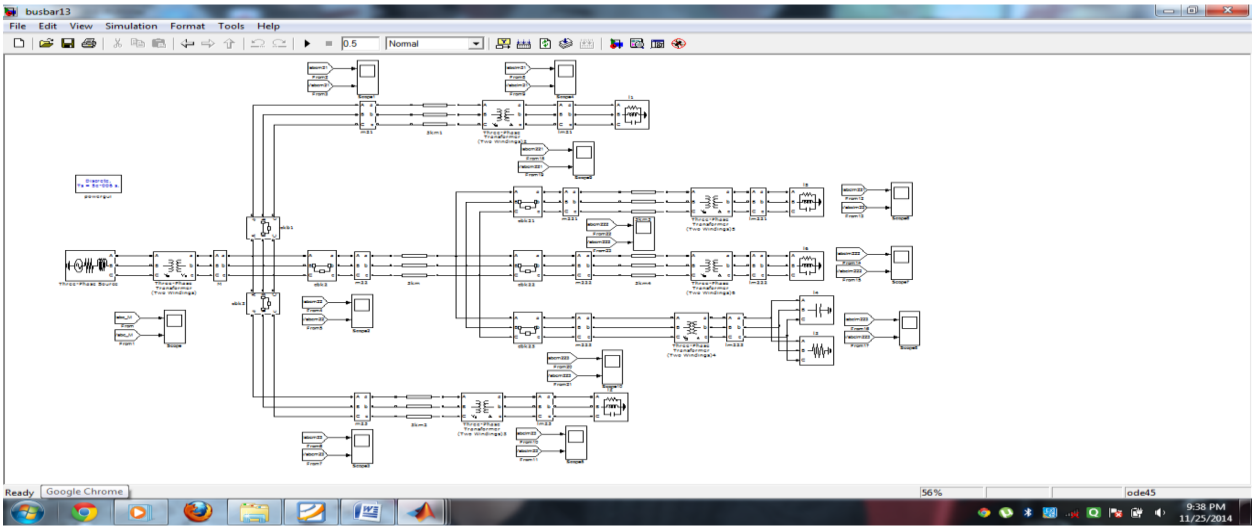

Fig. 2: MATLAB Model of 13 Bus bar system without fault

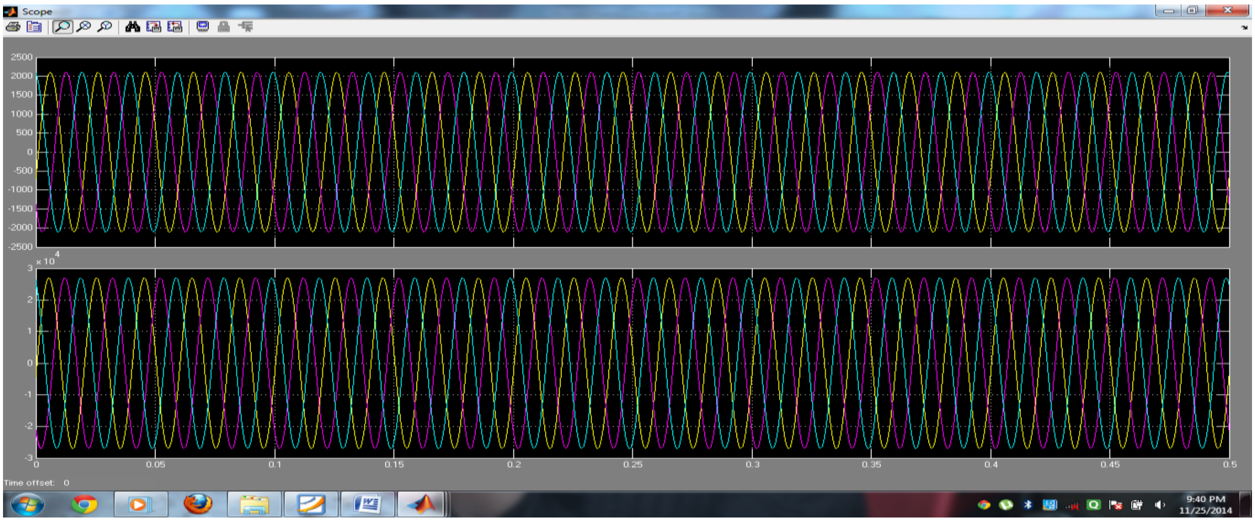

Fig. 3: Voltage & Current Waveform13 Bus bar system without fault

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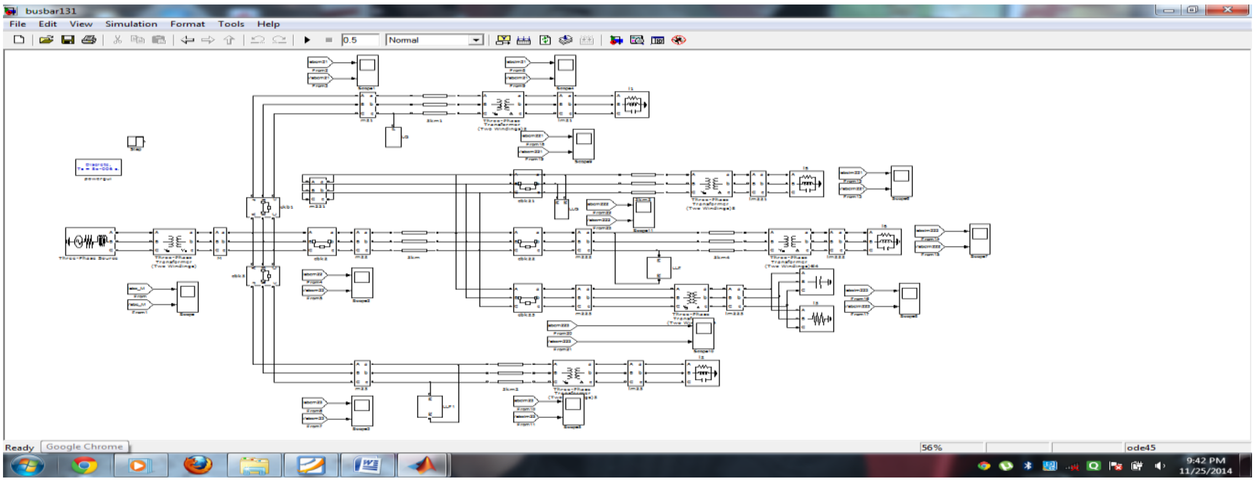

Fig. 4: MATLAB Model of 13 Bus bar system with fault

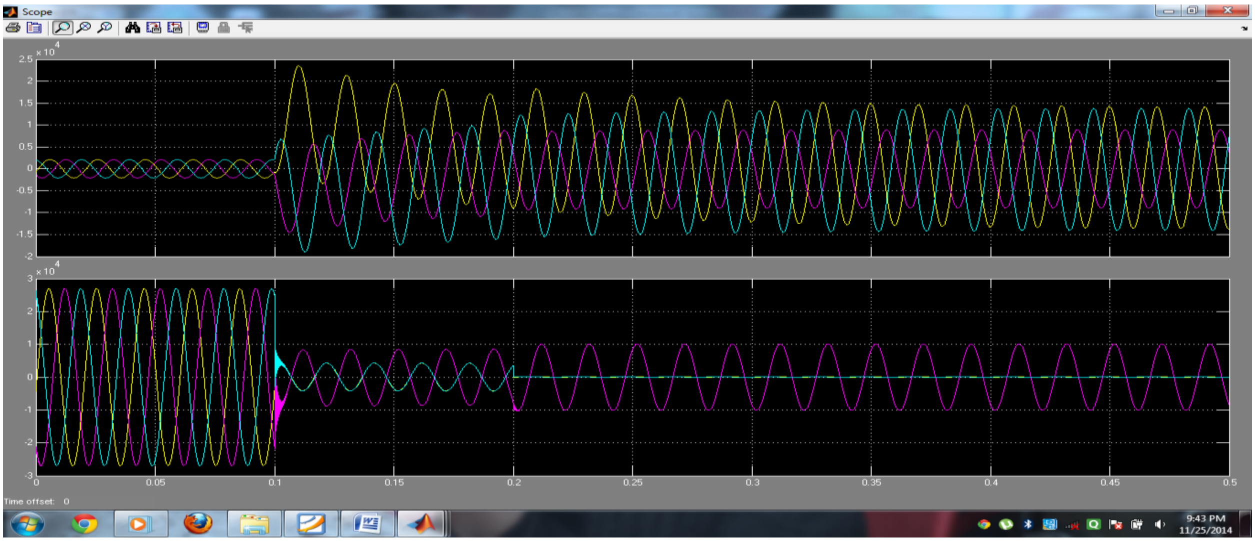

Fig. 5: Voltage & Current Waveform13 Bus bar system with fault

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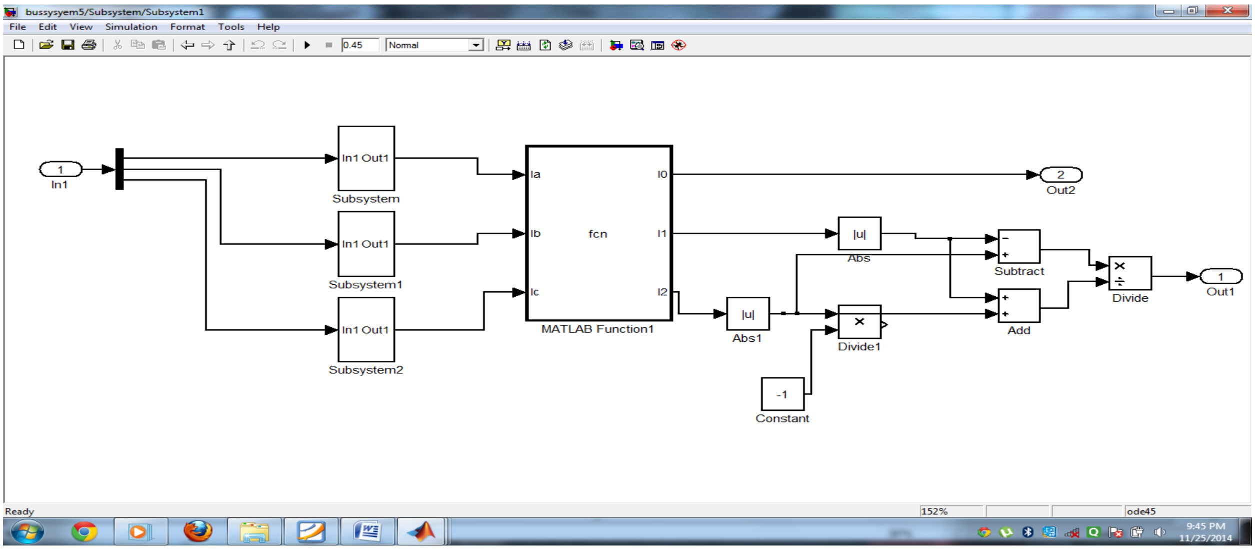

Fig. 6: Subsystem for subsystem 4

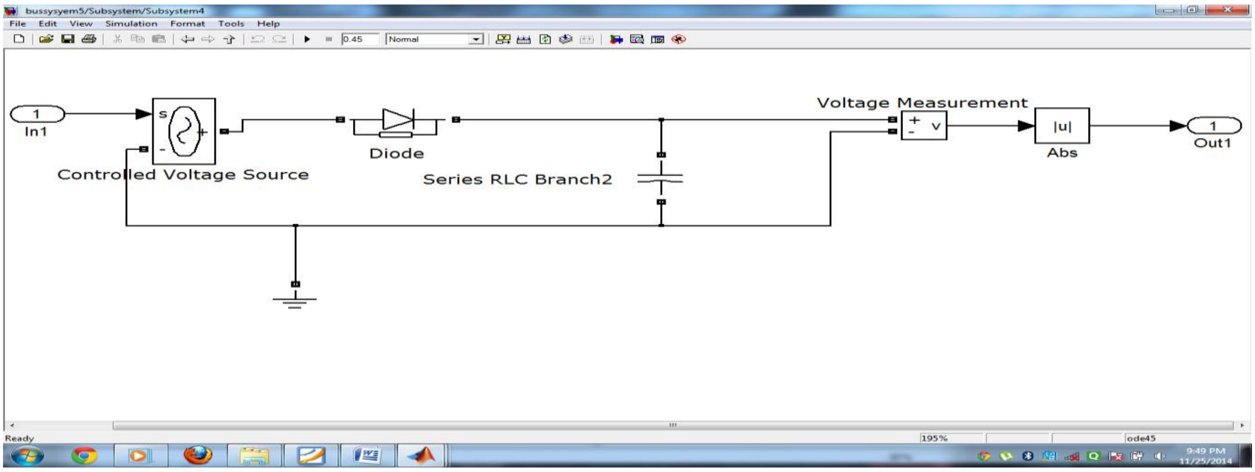

Fig. 7: Subsystem for subsystem 4(gate 2)

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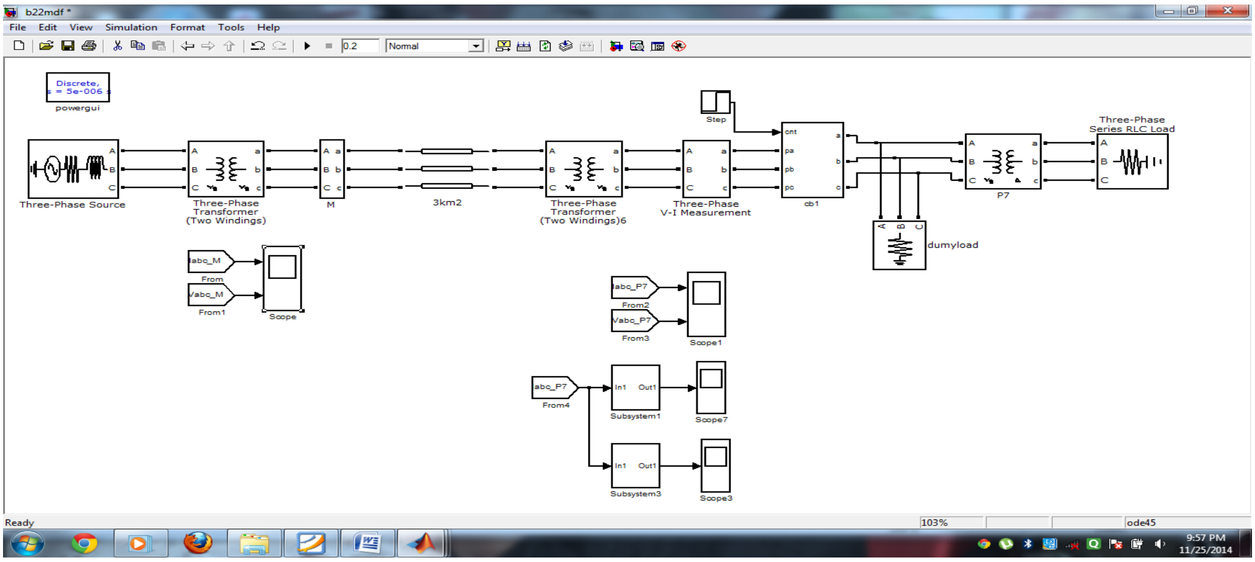

Fig. 8: Transformer Energizing on bus 9

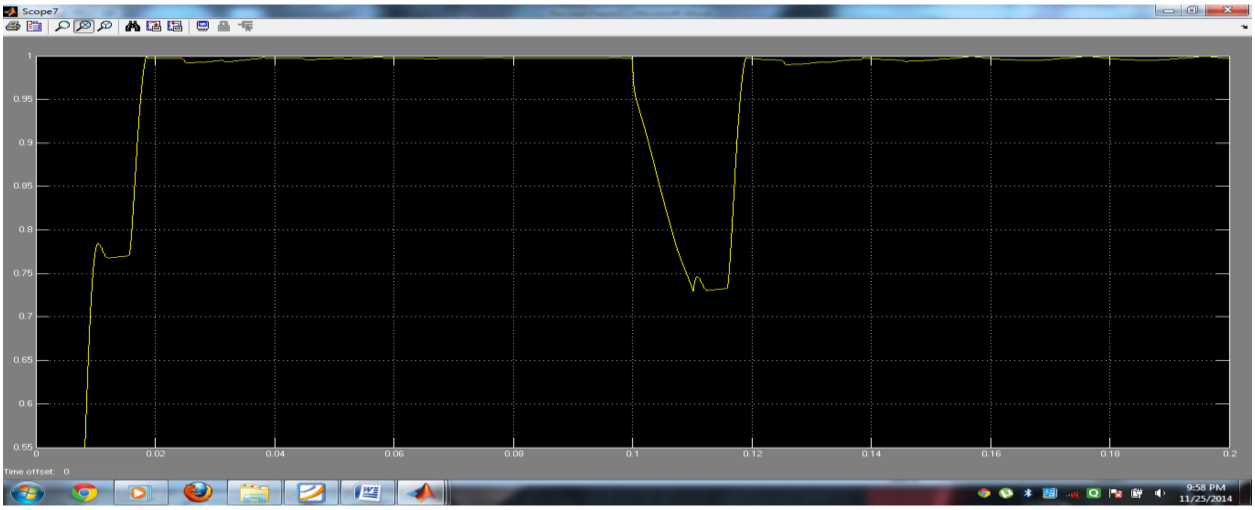

Fig. 9: Value of Criterion Function with transformer switching on Bus

Case-I: By considering asymmetrical different faults

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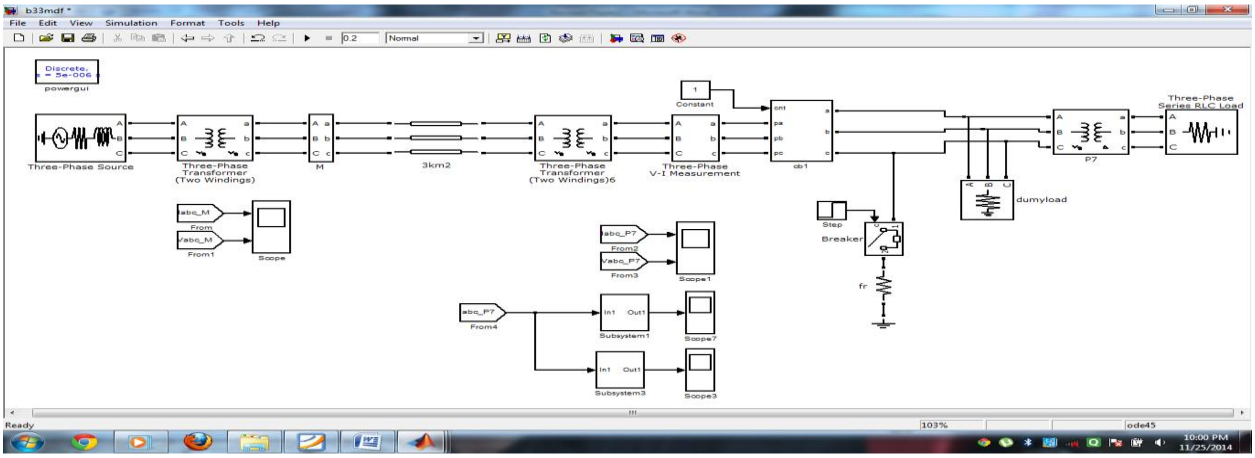

Fig. 10: LG Fault on bus 9

Fig. 11: Value of ‘R’ versus Time due to LG on Bus 9

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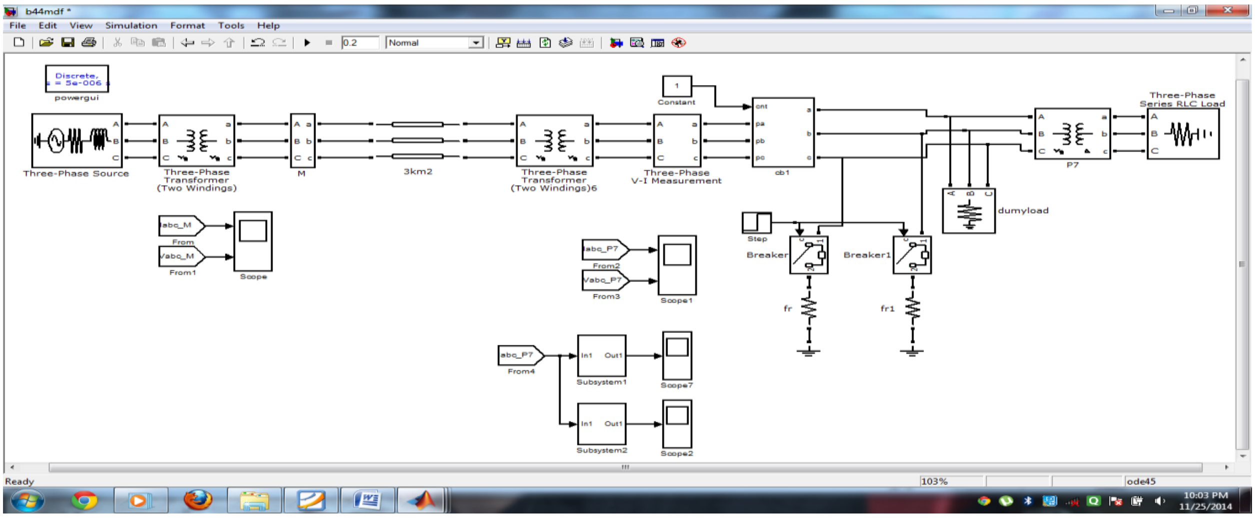

Fig. 12: LLG Fault on bus 9

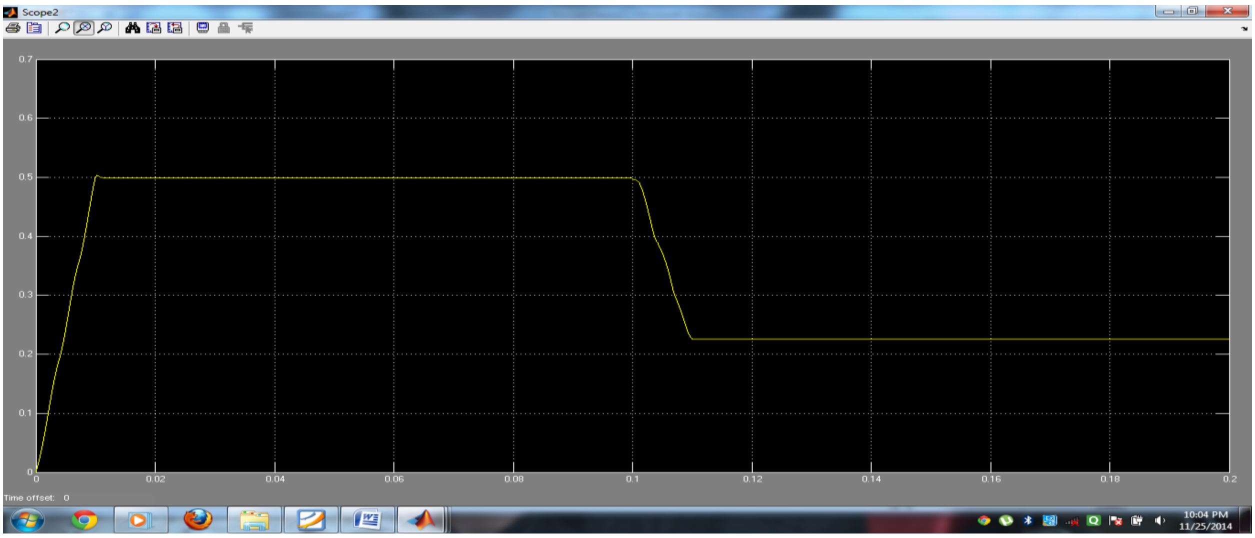

Fig. 13: Value of R by LLG Fault on bus 9

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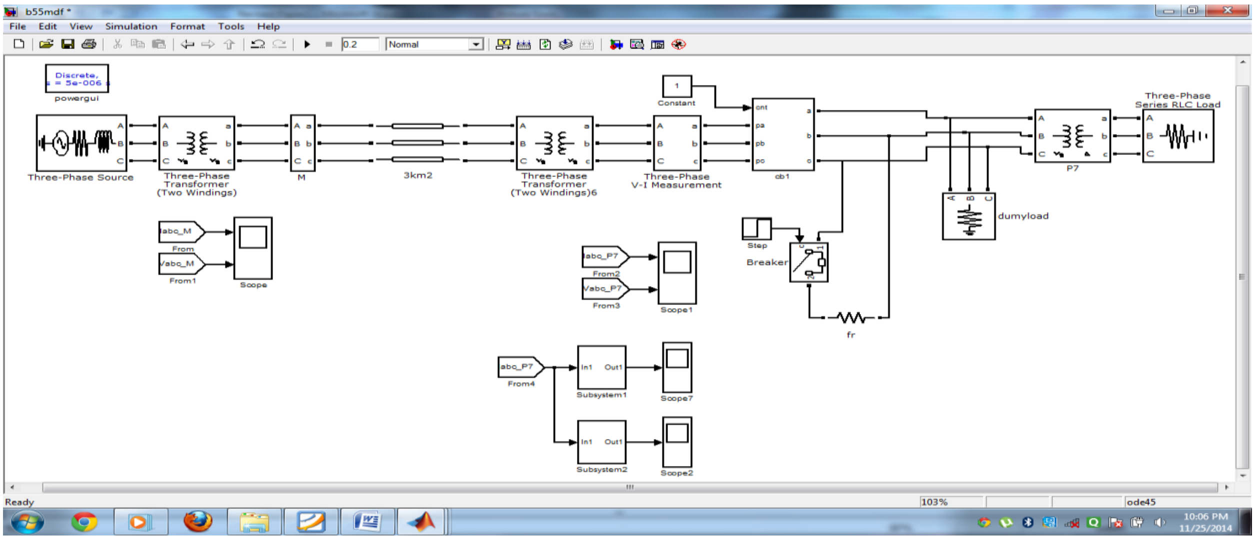

Fig. 14: LL Fault on bus 9

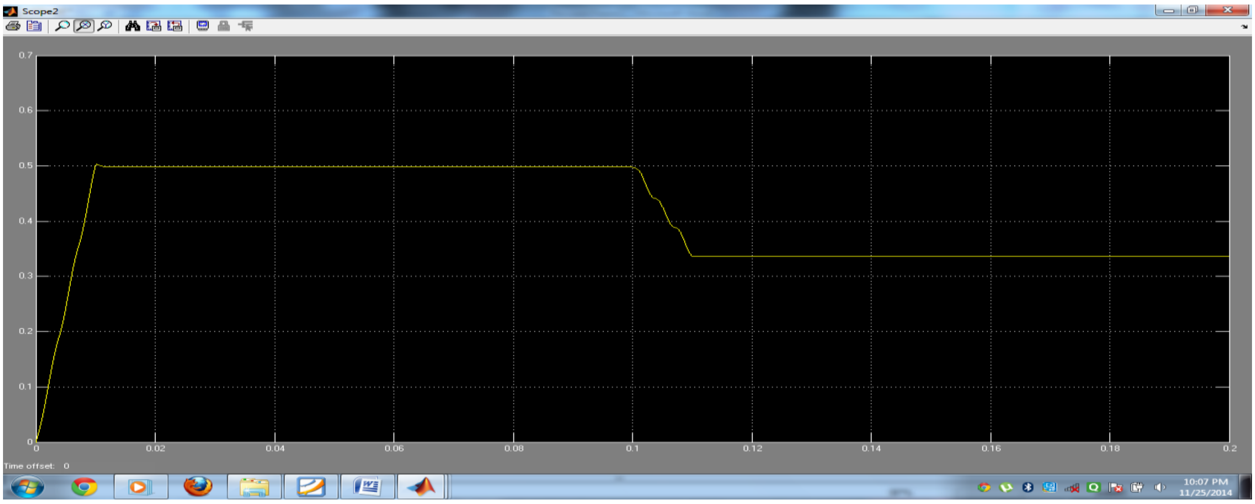

Fig. 15: Value of R by LL Fault on bus 9

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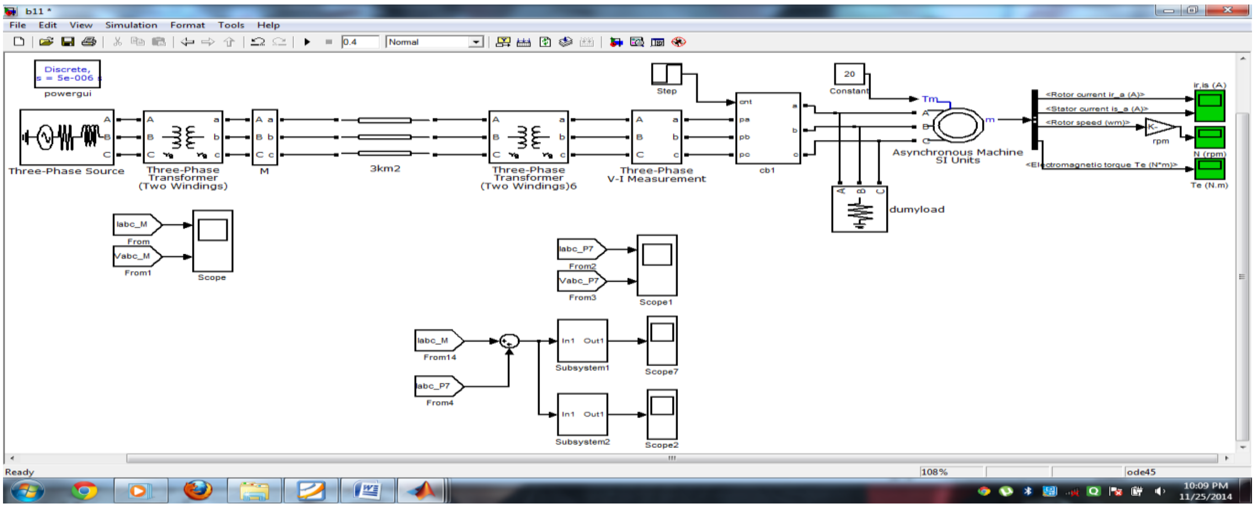

Fig. 16: Motor switching on bus 9

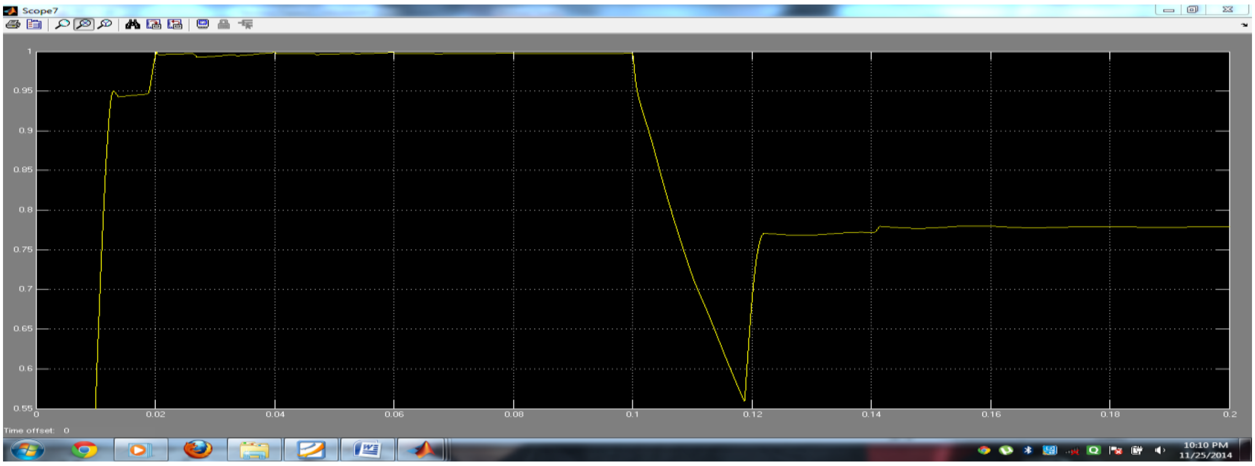

Fig. 17: Value of Criterion Function R on bus 9

Case-II: Fault through low resistance

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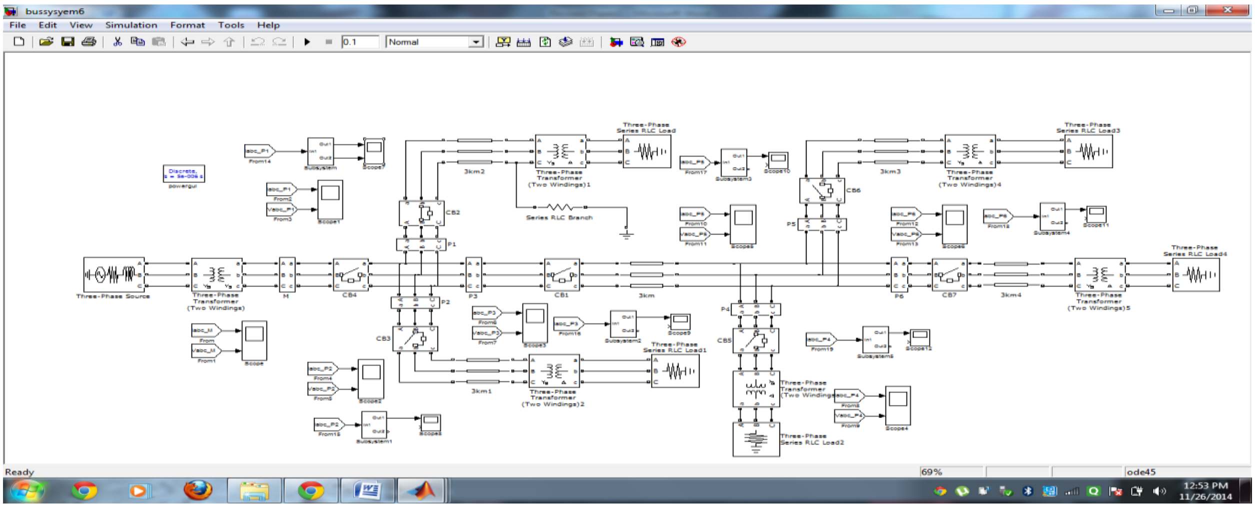

Fig. 18: LG Fault with Overcurrent Relay on Bus 4

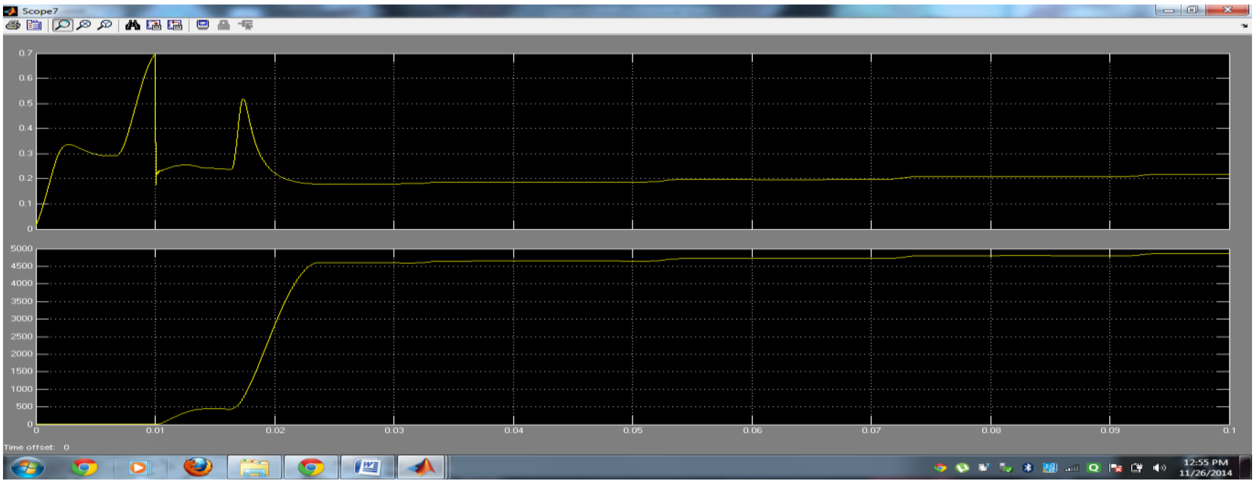

Fig. 19: Value of ‘R’ versus Time and I_o due to LG Fault with Overcurrent Relay on Bus 4

VI. RESULT

The nature of plots for value of ‘R’ versus time and three phase currents due to three phase short circuit with overcurrent relay are shown in fig. 18 and fig. 19 on bus 4, respectively. The three phase current waveforms of LG, LL, LLG, and simultaneous LL and transformer energizing are same for ground fault and fault through low resistance as due to overcurrent relay the faulty phases are disconnected on occurrence of fault. The criterion function ‘R’ as a decision making box can be implemented in relay and gives the signal to the circuit breaker for exact operation of the system, while switching and fault conditions. Maloperation can be avoided and continuous power supply will be easily available without any disturbance.

REFERENCES

[1] SaeedLotfi-fard, JawadFaiz, Reza Iravani, "Improved Overcurrent Protection Using Symmetrical Components",*IEEE TRANSACTION ON POWER DELIVERY*, Vol. 22. No. 2 April 2007.
[2] D. V. Kotkar, N. B. Wagh, "Identification of Fault Condition and Switching Event for Improvement of Overcurrent using Symmetrical Components*", INTERNATIONAL JOURNAL OF ELECTRICAL ELECTRONICS & COMPUTER SCIENCE ENGINEERING, Volume 1, Issue 6, December, 2014.*
[3] R. V. Katre, D. S. Chavan, S. S. Sardey, "Discrimination Of Fault From Non-Fault Event In Transformer Using Concept Of Symmetrical Components", INTERNATIONAL *JOURNAL OF COMPUTATIONAL ENGINEERING RESEARCH,* Vol. 3.Issue 3.
[4] H. Abniki, A. Majzoobi, H. Monsef, et. al., "Identifying Inrush Currents from Internal Faults Using Symmetrical Components In Power Transformers" *MODERN ELECTRIC POWER SYSTEM* 2010.
[5] SuchitaSardey, K. D. Thakur, Sunil Sardey, "Concept of Symmetrical Component asa Technique for Analysis of Fault and Improvement of Overcurrent Protection Scheme" *INTERNATIONAL JOURNAL OF ELECTRICAL AND ELECTRONICS ENGINEERING*. ISSN: 2231-5284, Vol.-I, Issue-II, 2011.
[6] A. T. Johns and S. K. Salman, "Digital Protection for Power Systems", Stevenage, U.K.: Peregrinus, pp. 1 – 5, 1995.
[7] K. Inagaki and M. Higaki, "Digital Protection Method for Power Transformers based on an Equivalent Circuit composed of Inverse Inductance", IEEE Trans. Power Del., Vol. 4, No. 3, pp. 1501–1510, Jul – 1998.
[8] J. H. Brunke and H. J. Frohlich, "Elimination of Transformer Inrush Currents by Controlled Switching-Part II: Application and Performance Considerations", IEEE Trans. Power Del., Vol. 16, No. 2, pp. 281–285, Apr – 2001.
[9] G. C. Gomez and M. M. Morcos, "A Simple Methodology for Estimating the Effect of Voltage Sags Produced by Induction Motor Starting Cycles on Sensitive Equipment", Proc. IEEE 36th Annual Meeting Conf., Vol. 2, pp. 1196–1199, Oct – 2001.
[10] L. A. Kojovic and J. F. Witte, "Improved Protection Systems using Symmetrical Components", IEEE, pp. 47 – 57, 2001.
[11] A. Guzman, S. Zocholl, G. Benmouryal, and H. J. Altuve, "A Current based Solution for Transformer Differential Protection-Part I: Problem Statement", IEEE Trans. Power Del., Vol. 16, No. 4, pp. 485–491, Oct – 2001.

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