Impact of Distributed Generation on Short Circuit Level

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Abstract

This paper describe effect of Distributed Generation on short circuit level. Distributed generation attracting in medium voltage transmission and distribution power system. As the Nonrenewable sources are on the way of exhausting, so we need to generate more electricity from renewable sources. These sources are used in distributed generation so there is more importance of distributed generation in power system. Insertion of DG has some impact on power system. This Paper deals with the evaluation of impact of DG on short circuit level of power system by simulating LG, LL and LLLG faults at different inception angles. The work presented in this paper consists of a two bus radial power system simulated in PSCAD/EMTDC software. Monitoring of fault current, load current and bus voltages is done in the simulation.
Keywords: Distributed Generation, Renewable Energy, Incepation Angle

I. INTRODUCTION

As the power demand is increasing day by day the utility has to feed power in the grid to fulfill the demands. In order to maintain this power balance use of renewable sources is increasing using a DG technology. Also this DG's is used in areas where the grid is nonexistent. Increase in the use of DG will have some impacts also there are several problems with the interconnection of DG with the grid. The performance of distribution system is affected by distributed generation of various ways. As DG is related to renewable energy for lowering environmental impact on power generation indicate a large scope for DG in future [1] [2]. DG improves voltage profile of a system. The losses in the circuit can be minimized if the DG is connected near to the load. Inserting DG will have an effect on short circuit level, transient stability [4] of system, voltage control [8], power quality, which can give a proper operation and protection over power system. In order to increase the penetration level of DG in power system, study of its impact on power system and to determine remedies against it.

II. DISTRIBUTED GENERATION

Distributed Generation (DG) is one of the new technologies which is focused on last few years and day by day its use for distribution networks is increasing [5]. It is presented in many forms such as solar (PV), wind (wind farms) with small scale ratings up to 10MW. It is referred to generate electricity and supplying this electricity to customers with their locations, it can also be interconnected with the utility grids. There are so many exemptions from a DG given to the customers. This privileges various types of advantages to install a DG rather than constructing new distribution lines. DG can be used to provide electric supply of customers during peak load hours, it can satisfy a consumer demand apart from the grid, thus it can also support to an intentional islanding [7]. One of the major problems that have to be considered to achieve a safe and effectively use of DG its interconnection between the utility grids [6].

III. IMPACT OF DISTRIBUTED GENERATION ON POWER SYSTEM

Insertion of DG in distribution systems has several impacts on it. These impacts may be positive or negative in power System [3].and they can be considered as the advantageous and disadvantageous of the distributed generation. This part is addressing the effects of DG on different features of the network.

1) Impact of DG on Voltage Regulation
2) Impact of DG on Losses
3) Impact of DG on Harmonics
4) Impact of DG on Power Quality
5) Impact of DG on Short Circuit Levels of the Network

Penetration of DG in a network has a direct impact on the short circuit levels of the network; it causes an increase in the fault currents when compared to the normal network conditions at which the substation is the only generating unit. This increase will be obtained even if the DG is of small generating capacity [6].The contribution to DG to faults depends on some factors such as the generating capacity of the DG (size of the DG), the distance from the DG from the fault location and the type of DG.

IV. SYSTEM UNDER STUDY

In this paper work a radial two bus distribution system of 12 kV is simulated in PSCAD/EMTDC simulation software. In Fig.1 DG inserted at bus 2. This system consists of main source (Grid) of 69 kV, two buses, transmission line, transformer and high voltage load on bus 2.

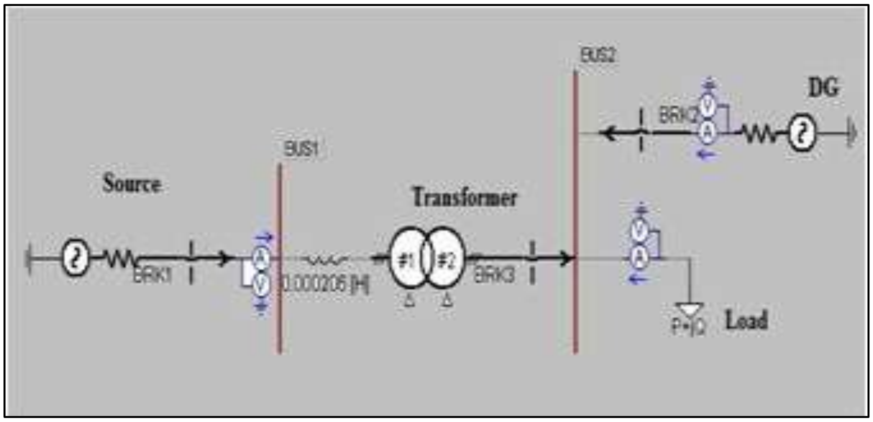

Fig. 1: PSCAD simulation of two bus radial system

V. SIMULATION RESULTS

The work presented in this paper consist of following cases

A. Case I. System with source and DG

In this case both source and DG are connected. So load draws a load current from source as well as DG. The magnitude of load current is the sum of source current and DG current which verifies Kirchhoff's current Law. Fig.2 represents the waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end and RMS voltage of receiving end obtained from PSCAD simulation.

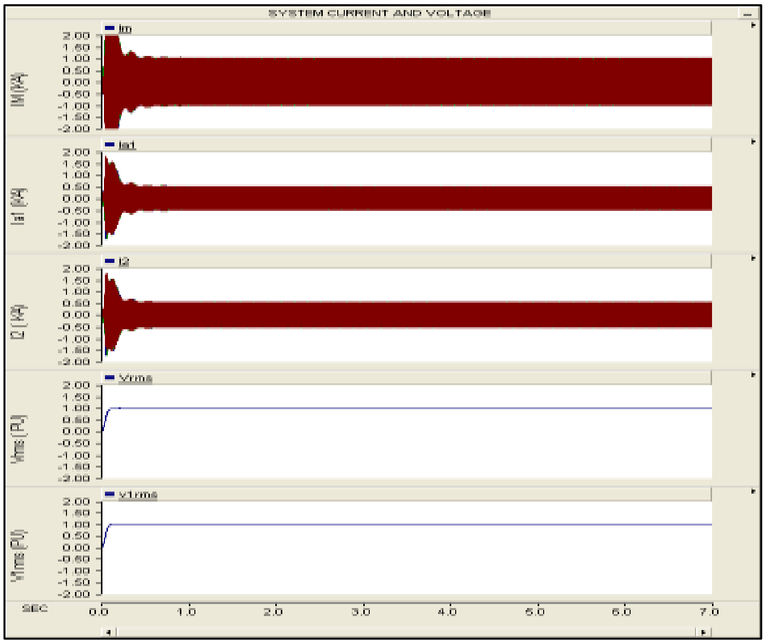

Fig. 2: Currents and voltages waveform of radial power system with source and DG

B. Case II:- System with Source and without DG.

In this case only source is connected so, load draws a load current from source. The magnitude of load current is equal to the of source current which verifies Kirchhoff's current Law. Fig.3 represents the waveforms of current drawn by the load, current supplied by the source, RMS voltage of sending end and RMS voltage of receiving end obtained from PSCAD simulation.

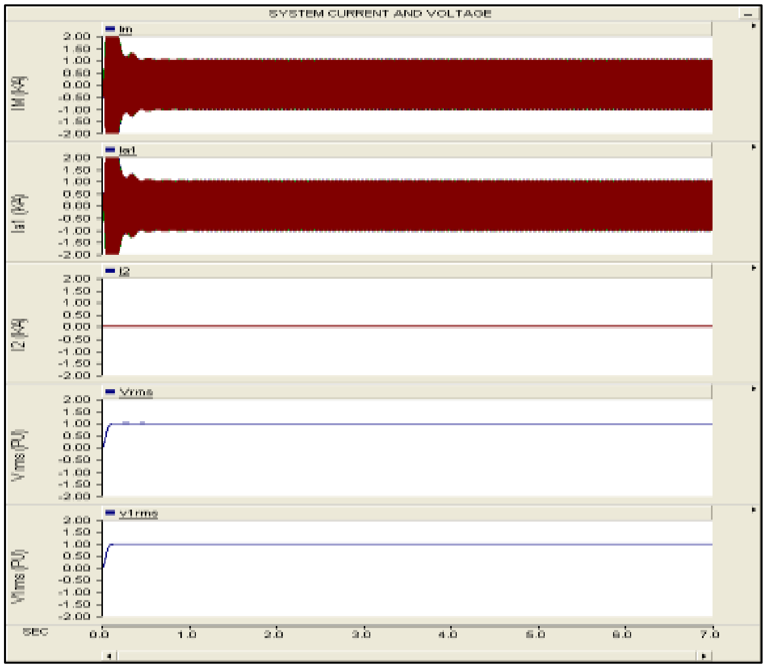

Fig. 3: Currents and voltages waveform of radial power system with source and without DG

C. *Case III. System with DG and without Source*

In this case only DG is connected. So load draws a load current from DG. The magnitude of load current is equal to the DG current which verifies Kirchhoff's current Law. Fig.4 represents the waveforms of current drawn by the load, current supplied by DG, RMS voltage of sending end and RMS voltage of receiving end obtained from PSCAD simulation.

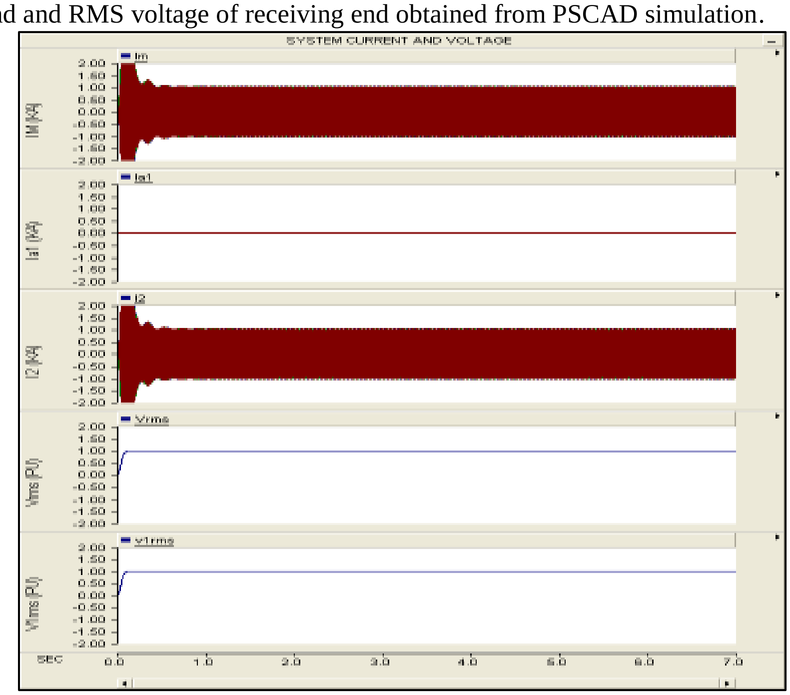

Fig. 4: Currents and voltages waveform of radial power system with DG and without source

Table- 1
Load, DG and Source current in case I, II and III

Cases	*Current in Previous Cases*		
	I_{Source}	I_{DG}	I_L
Case-I	*0.353 (kA)*	*0.362 (kA)*	*0.715(kA)*
Cases –II	*0.7148(kA)*	*0*	*0.7148(kA)*
Cases -III	*0*	*0.713 (kA)*	*0.713 (kA)*

D. Case IV: - Insertion of DG at different instant in a system with L-G, L-L and L-L-L-G Fault.

In this case initially only source is connected to the system with a fault occurring at 2sec for duration of 1 sec and DG is inserted at 2.5sec. Here we have simulated L-G, L-L and L-L-L-G faults and DG is inserted at 0° and 90° instant of blue phase.

Fig.5 represents the PSCAD simulation waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end, RMS voltage of receiving end and fault current under the influence of L-G fault during 2-3sec. The DG is inserted into 0° instant (2.5sec) of blue phase. From the simulation waveform it is observed that the magnitude of fault current increases to the insertion of DG. Also the magnitude of load current, source current, DG current and bus voltages are affected due to DG.

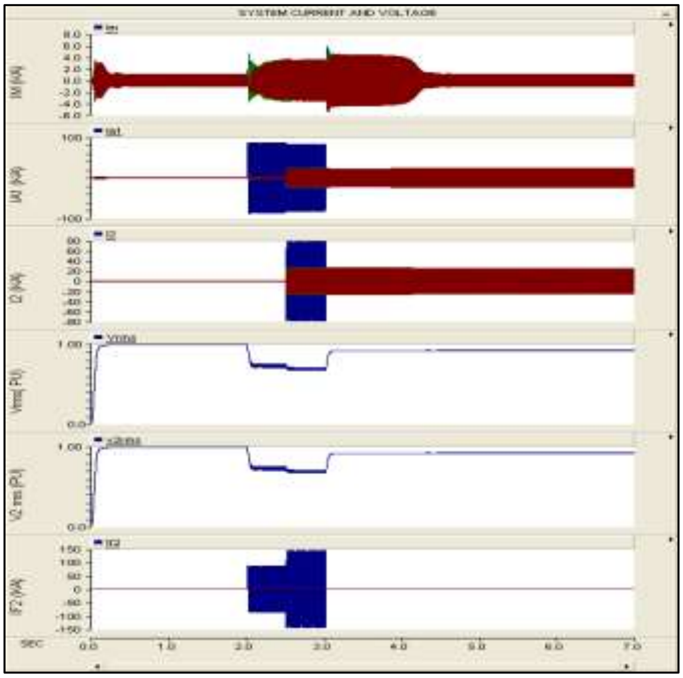

Fig. 5: Currents and voltages waveform of radial power system under the influence of L-G fault and insertion of DG at 0° instant of blue phase

Fig.6 represents the PSCAD simulation waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end, RMS voltage of receiving end and fault current under the influence of L-L fault during 2-3sec. The DG is inserted into 0° instant (2.5sec) of blue phase. From the simulation waveform it is observed that the magnitude of fault current increases to the insertion of DG. Also the magnitude of load current, source current, DG current and bus voltages are affected due to DG.

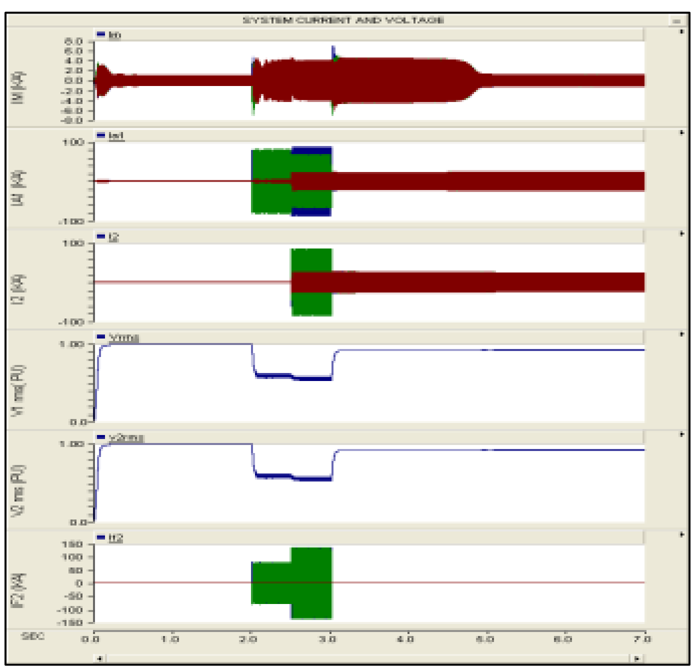

Fig. 6: Currents and voltages waveform of radial power system under the influence of L-L fault and insertion of DG at 0° instant of blue phase

Fig.7 represents the PSCAD simulation waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end, RMS voltage of receiving end and fault current under the influence of L-L-L-G fault during 2-3sec. The DG is inserted into 0° instant (2.5sec) of blue phase. From the simulation waveform it is observed that the magnitude of fault current increases to the insertion of DG. Also the magnitude of load current, source current, DG current and bus voltages are affected due to DG.

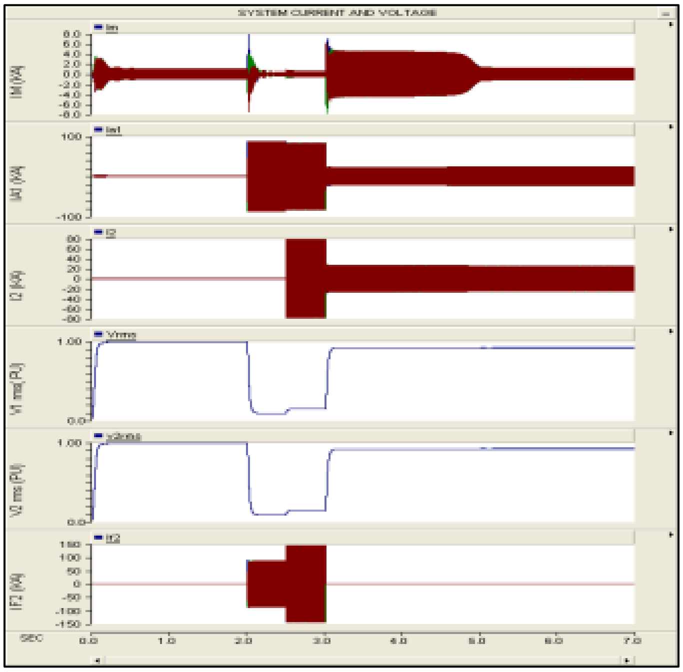

Fig. 7: Currents and voltages waveform of radial power system under the influence of L-L-L-G fault and insertion of DG at 0° instant of blue phase

Fig.8 represents the PSCAD simulation waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end, RMS voltage of receiving end and fault current under the influence of L-G fault during 2-3sec. The DG is inserted into 90° instant (2.5041 sec) of blue phase. From the simulation waveform it is observed that the magnitude of fault current increases to the insertion of DG. Also the magnitude of load current, source current, DG current and bus voltages are affected due to DG.

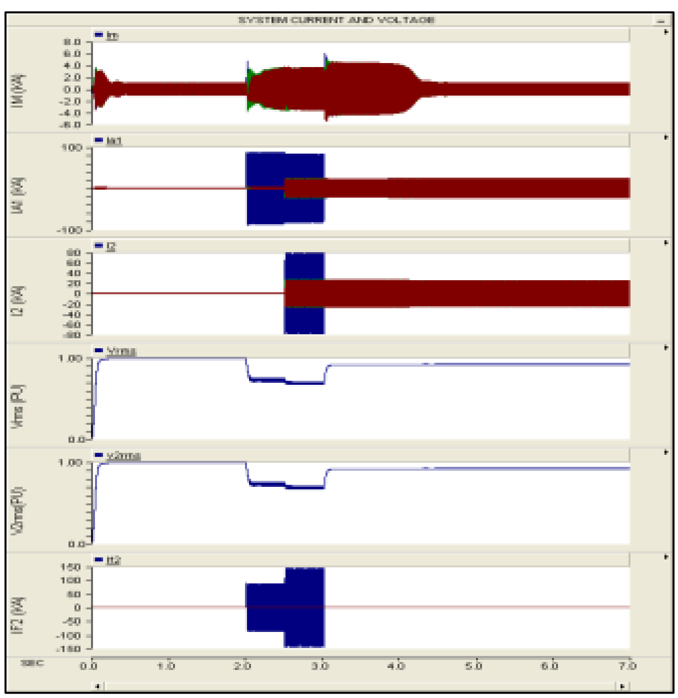

Fig. 8: Currents and voltages waveform of radial power system under the influence of L-G fault and insertion of DG at 90° instant of blue phase

Fig. 9 represents the PSCAD simulation waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end, RMS voltage of receiving end and fault current under the influence of L-L fault during 2-3sec. The DG is inserted into 90° instant (2.5041 sec) of blue phase. From the simulation waveform it is observed that the magnitude of fault current increases to the insertion of DG. Also the magnitude of load current, source current, DG current and bus voltages are affected due to DG.

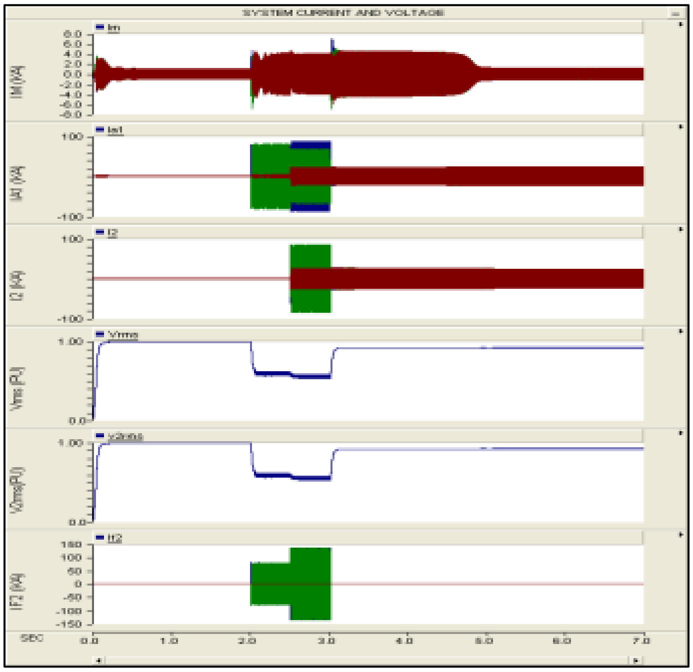

Fig. 9: Currents and voltages waveform of radial power system under the influence of L-L fault and insertion of DG at 90° instant of blue phase

Fig.10 represents the PSCAD simulation waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end, RMS voltage of receiving end and fault current under the influence of L-L-L-G fault during 2-3sec. The DG is inserted into 90° instant (2.5041 sec) of blue phase. From the simulation waveform it is observed that the magnitude of fault current increases to the insertion of DG. Also the magnitude of load current, source current, DG current and bus voltages are affected due to DG.

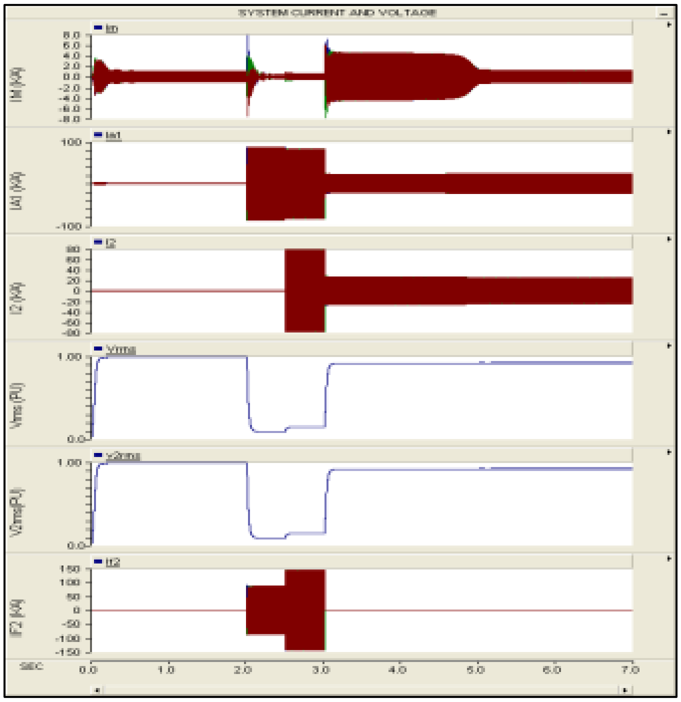

Fig. 10: Currents and voltages waveform of radial power system under the influence of L-L-L-G fault and insertion of DG at 90° instant of blue phase

Table - 2
Short circuit current in case IV with 0°and 90° Inception angle

Inception angle	*Types of fault*	*Short circuit current in (kA)*
0°	*L-G*	*57.01 (kA)*
	L-L	*44.394 (kA)*
	LLL-G	*73.46 (kA)*
90°	*L-G*	*86.52 (kA)*
	L-L	*55.05 (kA)*
	LLL-G	*88.52 (kA)*

E. Case V: - Simulation of L-G, L-L, and L-L-L-G Fault at different Inception angles in a system with DG.

In this case DG is already connected to the system with a fault occurring at 2.5 sec for duration of 1 sec. Here we have simulated L-G, L-L and L-L-L-G faults at 0° and 90° inception angles.

Fig.11 represents the PSCAD simulation waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end, RMS voltage of receiving end and fault current under the influence of L-G fault at 0^0 inception angle (2.5sec). From the simulation waveform it is observed that the magnitude of fault current increases to the insertion of DG.

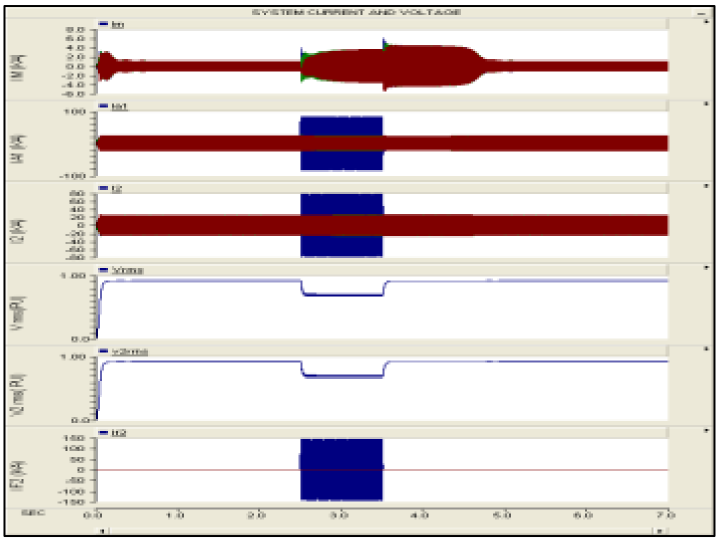

Fig. 11: Currents and voltages waveform of radial power system under the influence of L-G fault at 0° inception angle

Fig.12 represents the PSCAD simulation waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end, RMS voltage of receiving end and fault current under the influence of L-L fault at 0° inception angle (2.5sec). From the simulation waveform it is observed that the magnitude of fault current increases to the insertion of DG.

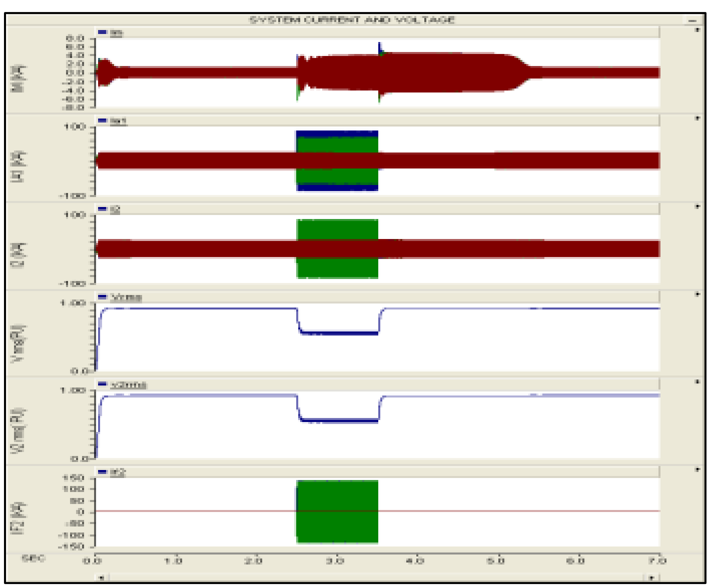

Fig. 12: Currents and voltages waveform of radial power system under the influence of L-L fault at 0° inception angle

Fig.13 represents the PSCAD simulation waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end, RMS voltage of receiving end and fault current under the influence of L-L-L-G fault at 0^0 inception angle (2.5sec). From the simulation waveform it is observed that the magnitude of fault current increases to the insertion of DG.

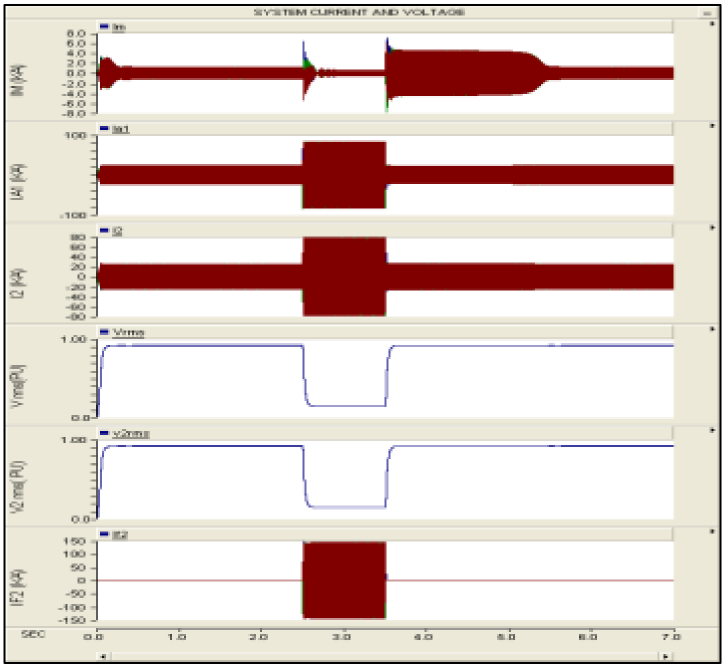

Fig. 13: Currents and voltages waveform of radial power system under the influence of L-L-L-G fault at 0° inception angle.

Fig.14 represents the PSCAD simulation waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end, RMS voltage of receiving end and fault current under the influence of L-G fault at 90^0 inception angle (2.5041sec). From the simulation waveform it is observed that the magnitude of fault current increases to the insertion of DG.

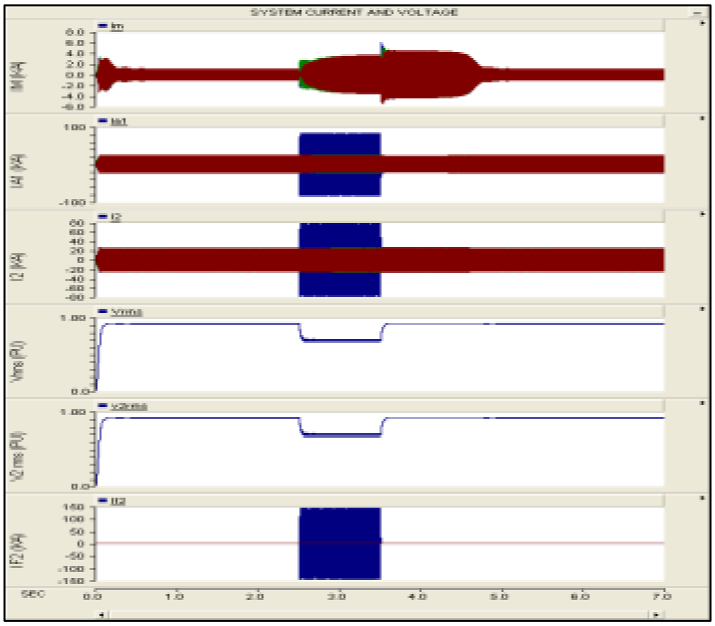

Fig. 14: Currents and voltages waveform of radial power system under the influence of L-G fault at 90° inception angle

Fig.15 represents the PSCAD simulation waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end, RMS voltage of receiving end and fault current under the influence of L-L fault at 90^0 inception angle (2.5041sec). From the simulation waveform it is observed that the magnitude of fault current increases to the insertion of DG.

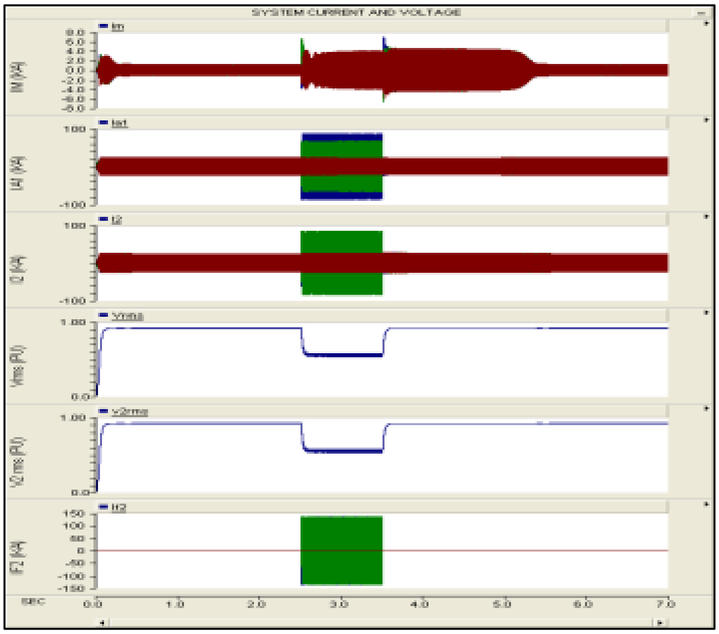

Fig. 15: Currents and voltages waveform of radial power system under the influence of L-L fault at 90° inception angle

Fig.16 represents the PSCAD simulation waveforms of current drawn by the load, current supplied by the source, current supplied by DG, RMS voltage of sending end, RMS voltage of receiving end and fault current under the influence of L-L-L-G fault at 90^0 inception angle (2.5041sec) .From the simulation waveform it is observed that the magnitude of fault current increases to the insertion of DG.

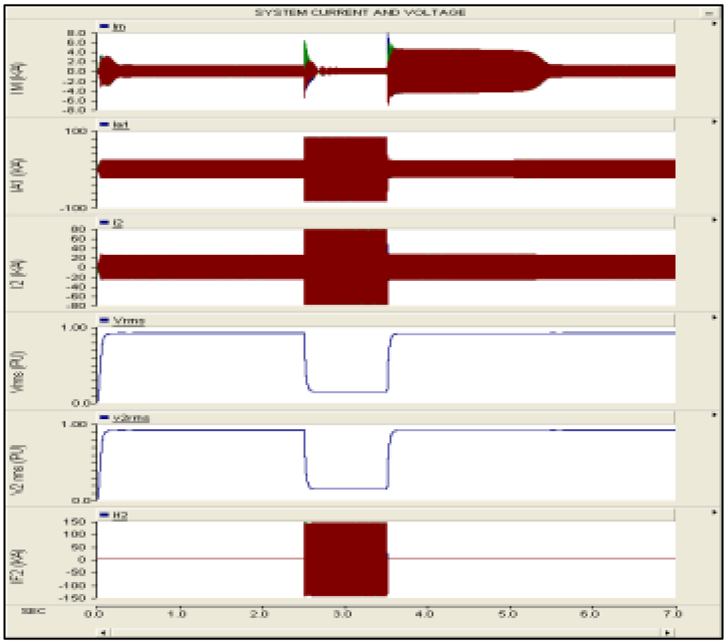

Fig. 16: Currents and voltages waveform of radial power system under the influence of L-L-L-G fault at 90° inception angle

Table - 3
Short circuit current in case V with 0°and 90° Inception angle

Inception angle	*Types of fault*	*Short circuit current in (kA)*
0°	*L-G*	*64.01 (kA)*
	L-L	*31.53 (kA)*
	LLL-G	*104.44 (kA)*
90°	*L-G*	*88.77 (kA)*
	L-L	*63.75 (kA)*
	LLL-G	*106.17 (kA)*

VI. Conclusion

Distributed Generation has various advantages though it is important the study of its impact on power system Simulation result to confirm that fault current increases to interconnection of DGs in existing systems.

The work presented in this paper leads to the conclusion that by adding DG at bus 2 it is observed that the current drawn by the load is the sum of both source current and DG current. It is also observed that DG contributes to the fault current so, in table II and III it is found that the magnitude of fault current i.e. Short circuit level increases in the insertion of DG in different instant 0° and 90^0. By comparing the magnitude of fault currents in case of LG, LL, and LLLG faults it is found that the magnitudes of fault current i.e. short circuit level is maximum in case of LLLG fault and minimum in case of LL fault is clear shown in case IV and V with different instant. As the short circuit level increases the short circuit MVA increases so in order to protect the system we need to change the rating of circuit breaker.

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