Study and Analysis of Faults with Different Grounding

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Abstract— Electric power system is most complex human made system where faults always occurred. These different types of faults are hazards for power system. Fault can cause equipment safety problems and economical loss. To avoid this type of difficulty generally solid grounding is use for faster protection. There are many types of faults in power system from this different type of fault only three faults are study here by simulation. In this paper LG, LLG and LLLG faults are simulated to limit fault current by using different grounding methods and then analysis is done to find what is the effect of this different grounding on ground current in time domain as well as in frequency domain.

Keywords: Electric Power System, Faults, Grounding, Fault Current

I. INTRODUCTION

Electric power system networks are applied all over the India and in many countries. Basically electric power system consists of three parts 1.Generation 2.Transmission 3. Distribution in all three parts grounding is important aspect for generator and transformers [1]. Different types of grounding are used for electric power system such systems are selected since they provide high degree reliability and service continuity [2]. This complete power system is established a decade ago now this system is very complex to study. In this complex system many faults are occurred. Faults are harmful for electric power system. Faults can results in economic losses. To solve this type of issue fault automatic detection location and isolation must be applied. Most of the faults in the power system make large change in per phase voltage and current value; these types of faults are generally detected by traditional relay or protective schemes. But these types of faults are very harmful for power system because of this large current it may goes to insulation brake down of the power system and many more effects on the power systems [3].

On alternator are over speed over voltage, over current, unbalanced loading ,failure of prime mover, , failure of field and stator winding faults (which includes line to ground faults, line to line faults, double line to ground fault, three phase fault and inter turn fault.)

In power system, earthing or grounding means connecting metal frame of electrical equipment (non-current carrying part) or some electrical part of the system (*e.g.* neutral point in a star-connected system, one conductor of the secondary of a transformer etc.) to earth *i.e.* soil[4]. This connection to the ground through the solid or through any other element like resistor or inductor depending upon the situation. Regardless of the method of connection to earth, earthing or grounding offers two principal advantages. First, it provides protection to the electric power system. For example, if the neutral point of a star-connected system is grounded through a circuit breaker with any element or through solid conductor and phase to earth fault occurs on any one line, a heavy fault current will flow through the circuit breaker [5]. The circuit breaker will open to isolate the faulty line. This protects the electric power system from the harmful effects of the fault. Secondly, earthing of electrical equipment (*e.g.* hand-held tools, domestic appliances, industrial motors etc.) ensures the safety of the handling the equipment [6][7]. For example, if insulation fails, there will be a direct contact of the live conductor with the frame of the equipment. Any person in contact with the frame part of this equipment will be subjected to a dangerous electrical shock which can be fatal. In this paper, we shall discuss the importance of earthing or grounding in the line of electric power system with special emphasis on neutral grounding [8].

In this paper different types of ground faults are study

1) Line to Ground fault (LG)
2) Double Line to Ground fault (LLG)
3) Triple Line to Ground fault (LLLG)

II. PERFORMANCE DURING DIFFERENT FAULT CONDITION

Here in this paper different types of faults are study related with different grounding to limit the fault current value. Generally in electrical power system solid grounding is use to protect the power system since because of its fast response to the protective scheme. But at the same time value of fault current is very large which is hazards for system. So to reduce fault current value as well the harmonics different grounding are used which reduce the fault current value up to the two times of its full load current so it is easy to operate for protective scheme as well the fault current value is under control. To explain this simulation is done by PSCAD software and the simulation circuit is shown below.

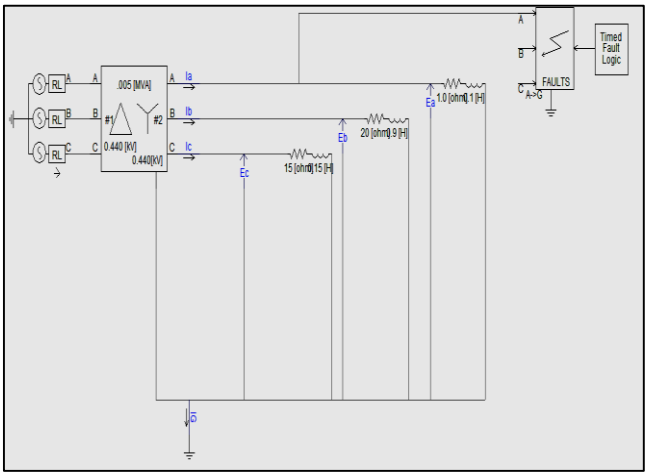

Fig. 1: Simulation Circuit

A. Line to Ground fault

Line to ground fault means when any one phase conductor connect to the ground is called as line to ground fault. This type of fault is generally called as asymmetrical fault since because of this type of fault current flowing through each phase is unbalance as well the voltage is also unbalance in

this type of fault the value of fault current is very high and the value of per phase voltage on faulty phase is very small nearly equal to zero. So here we are going to study LG fault with the help of different grounding methods. There are three types of grounding methods are generally utilized in our electric power system.

1) Solid grounding
2) Resistive grounding
3) Inductive grounding

1) Comparative Plot of all Ground Currents:

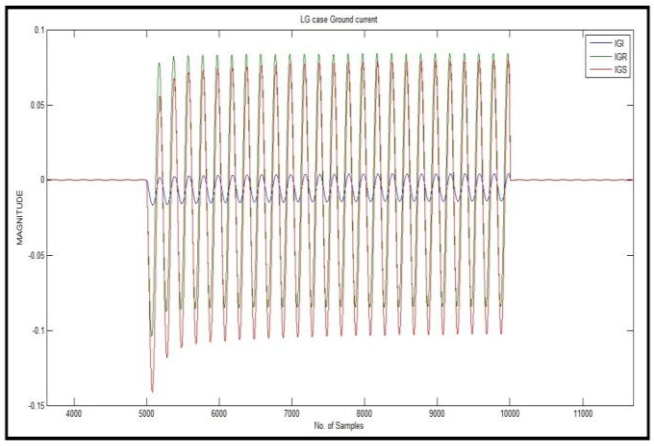

Fig. 2: Time domain waveform of L-G fault for all Groundings

Above fig. 2 shows the comparative plot of ground fault current in case of Solid grounding value of fault current is high; in case of Resistive grounding value of fault current is reduce and in case of Inductive grounding the value of fault current is very less.

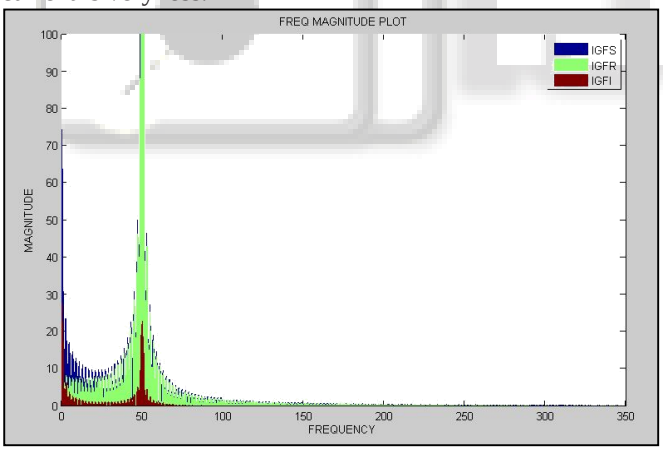

Fig. 3: Frequency domain waveform of L-G fault for all groundings

Above fig. shows the comparative graphical representation of ground fault current vs frequency in normalized form in frequency domain odd harmonics for resistive and inductive groundings are reduces.

B. Double Line to Ground fault

Double Line to ground fault means when any two phases connect to the ground is called as Double line to ground fault. This type of fault is generally called as asymmetrical fault since because of this type of fault current flowing through each phase is unbalance as well the voltage is also unbalance in this type of fault the value of fault current is very high and the value of per phase voltage on faulty phases is very small nearly equal to zero.so here we are going to study LLG fault with the help of different grounding methods. There are three types of grounding methods are generally utilized in our electric power system.

1) Solid grounding
2) Resistive grounding
3) Inductive grounding

1) Comparative Plot of all Ground Currents:

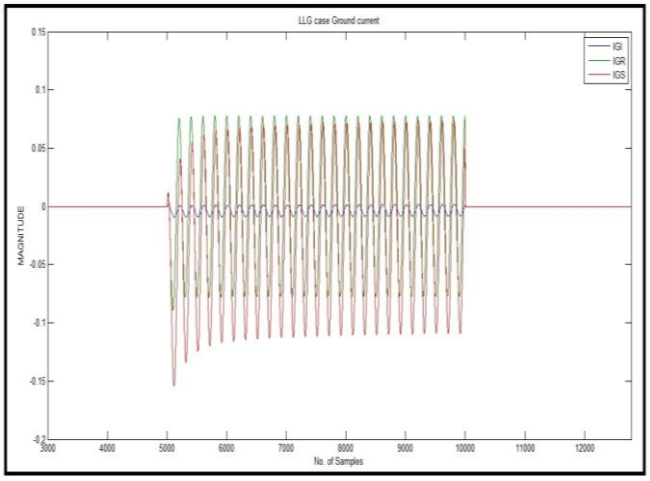

Fig. 4: Time domain waveform of LL-G fault for all Groundings

Above fig. 4 shows the comparative plot of ground fault current in case of Solid the value of fault current is high and for resistive and inductive grounding the value of fault current is limited.

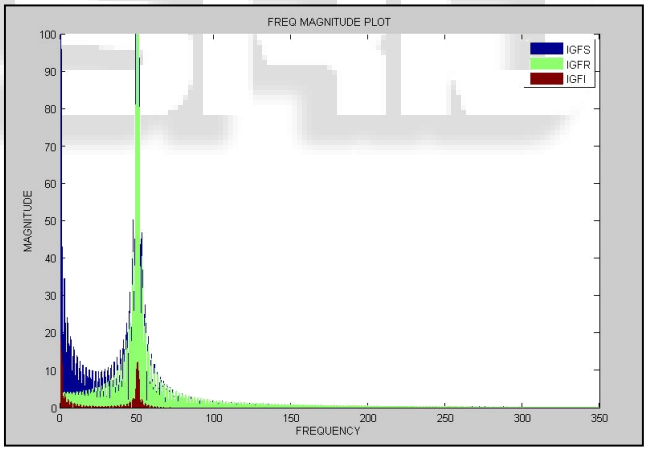

Fig. 5: Frequency domain waveform of LL-G fault for all groundings

Above fig. 5 shows the comparative graphical representation of ground fault current vs frequency in normalized form here also the odd harmonics reduces in resistive and inductive grounding.

C. Triple Line to Ground fault

Triple Line to ground fault means when any all phases connect to the ground is called as Triple line to ground fault. This type of fault is generally called as symmetrical fault since because of this type of fault current flowing through each phase is balance as well the voltage is also balance in this type of fault the value of fault current is very high and the value of per phase voltage on faulty phases is very small nearly equal to zero.so here we are going to study LLLG fault with the help of different grounding methods. There are three

types of grounding methods are generally utilized in our electric power system.

1) Solid grounding
2) Resistive grounding
3) Inductive grounding

1) Comparative Plot of all Ground Currents:

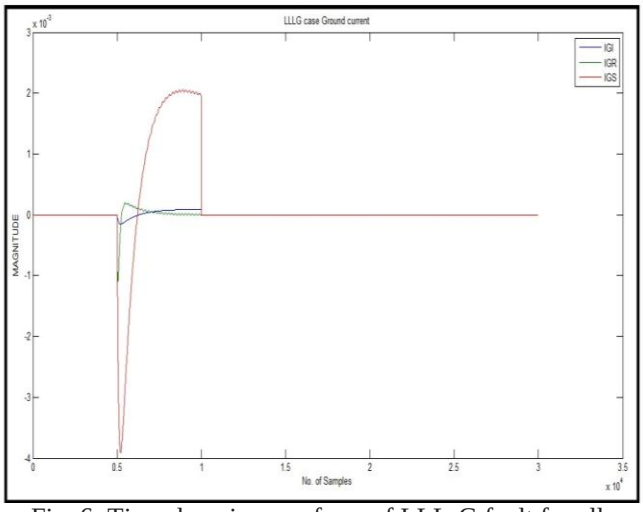

Fig. 6: Time domain waveform of LLL-G fault for all Groundings

Above fig. 6 shows the plot of voltages of three phases and the ground fault current where fault occurs on phase A, phase B and phase C.

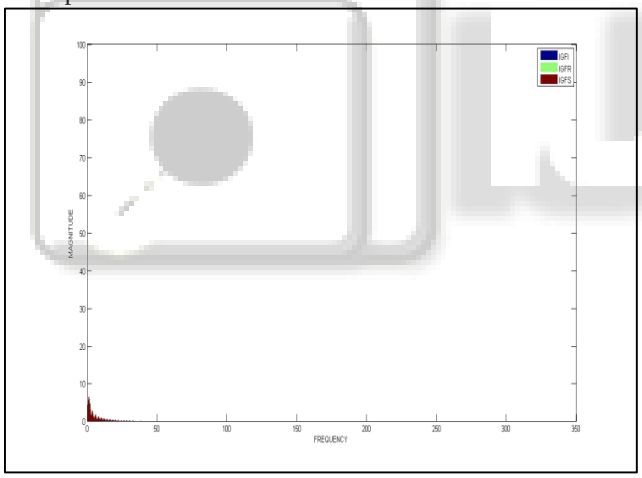

Fig. 7: Frequency domain waveform of LLL-G fault for all groundings

Above fig. 6 shows the comparative graphical representation of ground fault current vs frequency in normalized form.

III. CONCLUSION

In this paper, the characteristics of different grounding for different types of faults have been reviewed with the help of PSCAD. The impact of the ground fault current in different faults for different grounding is shown with comparative graphs. The value of fault current can be reduce by different grounding as well as the odd harmonics are also reduces. For low rating power system solid grounding are good but day by day electric power transmission rating are increase and solid grounding is not good for high rating power system since value of fault current is very high so to reduce this fault current resistive and inductive grounding can be used

REFERENCES

[1] Yexu Li & Farid Dawalibi "Advanced Practical Considerations of Fault Current Analysis in Power System Grounding Design" Journal of International Council on Electrical Engineering Vol. 2, No. 4, pp.409~414, 2012.

[2] Lei Dong, Lin He, Weidi Li, Xiao Ao "Study on Effect of Neutral Grounding Mode on Reliability of Distribution Network" Trans Tech Publications, Switzerland, Vols. 614-615, pp 719-723,2013.

[3] Marek Fulczyk and Joachim Bertsch "Ground-Fault Currents in Unit-Connected Generators with Different Elements Grounding Neutral" IEEE Transactions on Energy Conversion, VOL. 17, NO. 1, March 2002.

[4] Zhouxing Fu, NanWang, Lingling Huang, Ruoya Zhang "Study on Neutral Point Grounding Modes in Medium-voltage Distribution Network" IEEE 978-1-4799-5277-9/14,2014.

[5] Jinliang He, Jinpeng Wu, Bo Zhang and Rong Zeng "Fault Current-Division Factor of Substation Grounding Grid in Seasonal Frozen Soil" IEEE Transactions on Power Delivery, VOL. 28, NO. 2, APRIL 2013.

[6] B Yu, H Li, W J Zhu, H F Liu, W W Liang, Z D Zhang, S Y Guo "Grounding Fault Analysis and Protection Measures Study of Composite Grounding Arc-suppression Modes" 2nd International Conference on Power and Energy Engineering (ICPEE 2018).

[7] F. Dawalibi "Ground Fault Current Distribution Between Soil and Neutral Conductors" IEEE Transactions on Power Apparatus and Systems, Vol. PAS-99, No.2 March/April 1980.

[8] Haijun Liu, Massimo Mitolo and Jun Qiu "Ground-Fault Loop Impedance Calculations in Low-Voltage Single-Phase Systems" IEEE Transactions on Industry Applications, VOL. 50, NO. 2, March/April 2014.

