Study And Analysis of Neutral Grounding For Different Ground Faults

Mr. Shyam W. Agrawal[1], Mr. Chetan M. Bobade[2]
[1]Dept of Electrical Engineering
[2]Assistant Professor & Head of Department, Dept of Electrical Engineering
[1, 2]G.H.R.C.E.M. Amravati, Maharashtra, India Maharashtra, India

Abstract- *In an electrical power system different types of faults occur and the maximum faults are ground faults. The value of ground fault current is very high and which is the hazards of electrical power system. To limit this ground fault current different types of grounding can be used. In this paper all the ground faults are studies of solid, resistive and inductive grounding experimentally and then the effect of each grounding on ground faults current as well as on power quality explain. Grounding also affect the electrical power system protection scheme as the neutral grounding change the protection scheme must be changing as per the grounding. Since for each neutral grounding the value of fault current is different.*

Keywords- Electrical power system, faults, neutral, fault current.

I. INTRODUCTION

In an electrical power system initially ungrounded neutral system is accepted universally, but after considerable advantages of the neutral grounding grounded system is accepted throughout since grounded system is easy to protect as compare to ungrounded system. In an electrical power system different transmission voltage levels are preferred according to the physical conditions. There are many types of distribution and transmission system. In medium and low voltage transmission and distribution system, there are many types of ground faults are occurring which is hazards for the system as well as system equipment's.[1]

There are mainly three different types of fault occur Line to ground fault, Double line to ground fault and triple line to ground fault from all these three faults 85% of faults occurs in system are line to ground fault, only 3% to 5% faults are double line to ground and triple line to ground fault.[2] Most severe fault in power system is triple line to ground fault, but this is not true always but line to ground fault may be more severe than triple line to ground fault when the fault is at generator side or at terminals and it also depends on the value of neutral impedance. When any ground fault occurs in power system, then the value of ground current is very high and the value of the voltage on faulty phase is nearly equal to zero.[3] This fault current value is may damage system equipment's. Since the value of fault current is much higher than the rated value when the system is solid, grounded but at the same time as the system is solidly grounded it helps the protective scheme to operate fast since as the value of fault current high it is easily detected by relay.[4] For reliable and fast protection generally solid grounding is prefer but for safety point view the value of fault current must be reduced by using different grounding. Protective scheme of electrical power system may be working properly if the value of fault current is twice than that of full load current.[5][6] This value is easily detected by relay to isolate the healthy and faulty conditions at the same time the value of fault current is also reduced. So to reduce this fault current in electrical power system different grounding methods are use like solid grounding, resistive grounding and inductive grounding.[7] In this the paper the value of fault current is observed by experimental results were the experimental small electrical network is created in lab and then all the ground faults are created for all three different grounding the results of each grounding are stored in computer with the help of Digital Storage Oscilloscope (DSO) and then the analysis is done.

II. EXPERIMENTAL SETUP

A. Block diagram of experimentation

Here delta-wye distribution transformer is connected to the source and single phase load banks operate on it. By creating different types of faults such as L-G, LL-G, LLL-G on this isolated system with different grounding for each type of fault we analyzed the effect of grounding on fault current. By connecting DSO we captured different waveforms of voltages and fault currents.

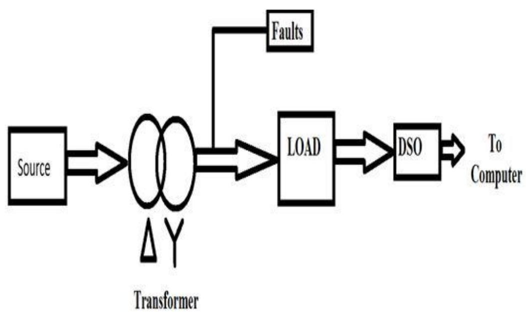
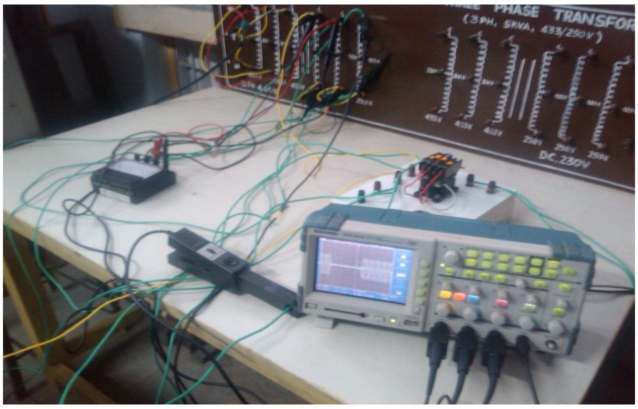


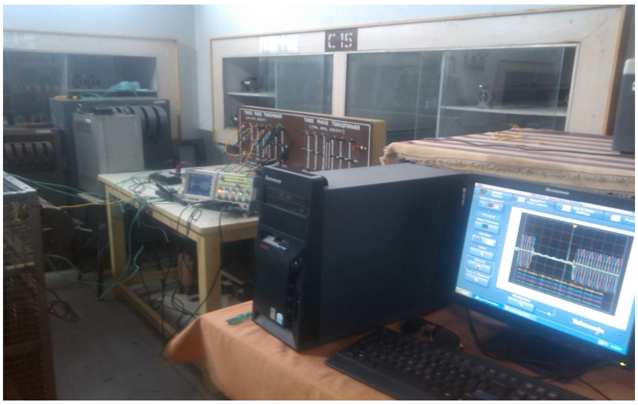
Figure 1: Block diagram of experimentation

B. Specification

Three phase transformer used in the experimentation has rated 5 KVA, 440/433V, 3.85/7.7A. The 4-channel Digital Storage Oscilloscope (DSO) used to capture the output data has a bandwidth of 100MHz. The CT used for measuring ground current has input current rating of 0 – 70 Amp r.m.s, peak current of 100A (AC/DC). It can measure current in the frequency range up to 100 KHz and gives output voltage 100mV/A. The input range of PT used is 1000 V and its bandwidth range is 200 MHz. The loads put upon the each phase were Resistive of 5KW. Rheostats of 100 Ω/5A were used to limit the ground fault current and the inductive coil of three phases, 400V, 15 A/ph was used. The wires used for the connection of setup were 2.5 Sq. mm, 1100V.

Pictures of Experimentation in Laboratory





III. RESULTS DURING DIFFERENT FAULT CONDITION

In this experimental setup different types of ground faults are created manually like LG, LLG and LLLG faults and in each fault different grounding are used like solid, resistive and inductive, then all the results are stored in Digital Storage Oscilloscope (DSO) and then converted into a graph with respective time domain and frequency domain then the analysis is done.

A. Line to Ground Fault

In electrical power system 85% faults are line to ground fault which is hazards for the power system as well as the power system equipment's in this fault the value of fault current is very high and odd harmonics are also present. So to reduce this fault current value as well, odd harmonics different grounding methods are used.

a. Solid grounding
b. Resistive grounding
c. Inductive grounding

a. Solid grounding

In solid grounding neutral is grounded with the minimum impedance conductor and the solid grounding is generally preferred since it is suitable for fast protection for the power system.[8] Following graph shows the ground current during LG fault.

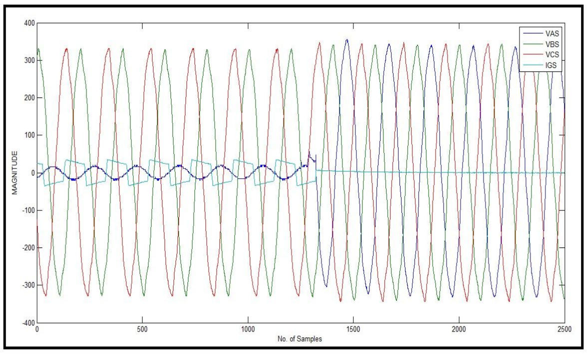


Figure 2: Time domain waveform of L-G fault for solid grounding

The above figure shows the plot of voltages of three phases and the ground fault current. Initially the ground current is very less but when a fault occurs in phase A, the ground current increases while the sag is observed in voltage.

b. Resistive grounding

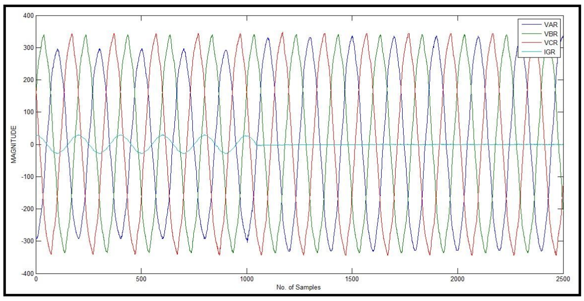


Figure 3: Time domain waveform of L-G fault for Resistive Grounding

The above figure shows the plot of voltages of three phases and the ground fault current. Initially the ground current is very less but when a fault occurs in phase A, the ground current increases and is limited by the resistance while the sag is observed in voltage in minimum than the previous.

c. Inductive grounding

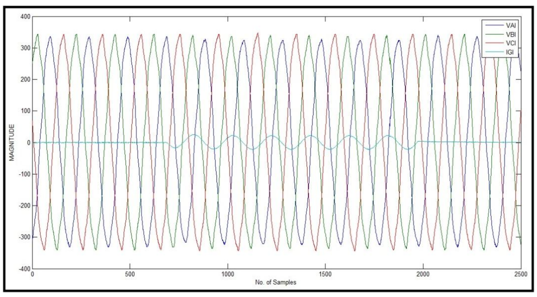


Figure4: Time domain waveform of L-G fault for inductive grounding

The above figure shows the plot of voltages of three phases and the ground fault current. Here the ground currents and various frequency components such as harmonics and inter-harmonics are attenuated as the current does not change instantaneously through the inductor.

1) Comparative Plot of all Ground Currents:

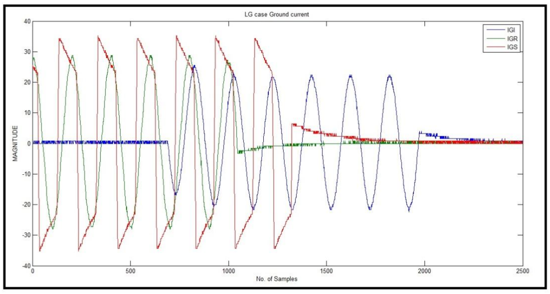


Figure 5: Time domain waveform of L-G fault for all groundings

The above figure shows the comparison plot of ground fault current in case of Solid, Resistive and Inductive grounding.

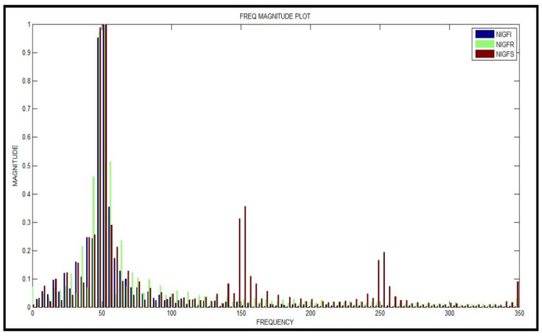


Figure 6: Frequency domain waveform of L-G fault for all groundings

The above figure shows the graphical representation of ground fault current vs frequency in normalized form.

B. Double Line to Ground Fault

In electrical power system 2% to 5% faults are double line to ground fault which is hazards of the power system as well as the power system equipment's in this fault the value of fault current is very high and odd harmonics are also present. So to reduce this fault current value as well, odd harmonics different grounding methods are used.

a. Solid grounding
b. Resistive grounding
c. Inductive grounding

1) Comparative Plot of all Ground Currents:

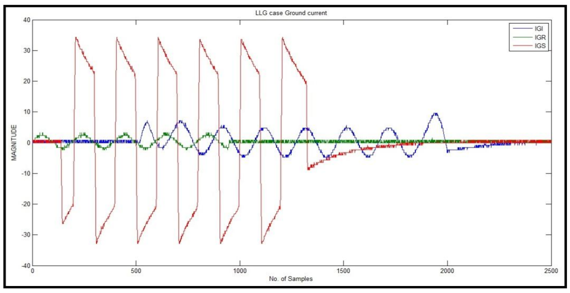


Figure 7: Time domain waveform of LL-G fault for all groundings

In the above figure comparative plot of LLG for all groundings is shown here the value of fault current for resistive and inductive grounding is less than that of solid grounding.

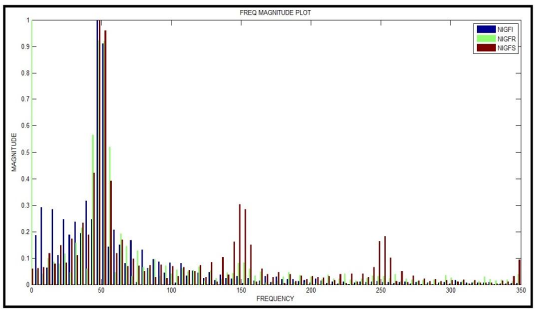


Figure 8: Frequency domain waveform of LL-G fault for all groundings

In the above figure comparative plot of LLG fault for all grounding is shown in frequency domain here it is clear that the odd harmonics are suppressed in resistive and inductive grounding.

C. Triple Line to Ground Fault

In electrical power system 2% to 5% faults are triple line to ground fault which is hazards of the power system as well as the power system equipment's in this fault the value of fault current is very high and odd harmonics are also present. So to reduce this fault current value as well, odd harmonics different grounding methods are used.

a. Solid grounding
b. Resistive grounding
c. Inductive grounding

1) Comparative Plot of all Ground Currents:

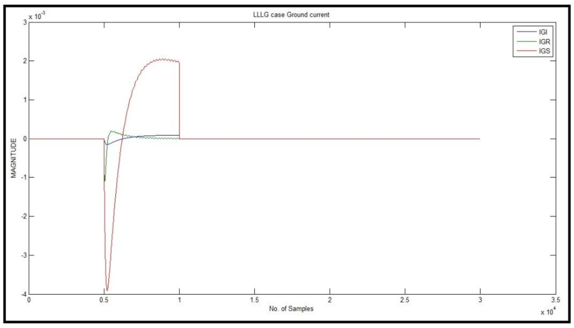


Figure9: Time domain waveform of LLL-G fault for all groundings

In the above figure comparative plot of LLLG for all groundings is shown here the value of fault current for resistive and inductive grounding is less than that of solid grounding

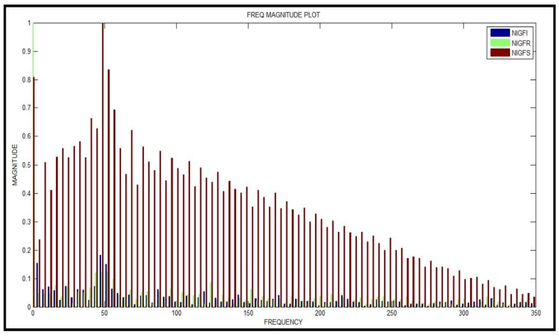


Figure 10: Frequency domain waveform of LLL-G fault for all groundings

In the above figure comparative plot of LLLG fault for all grounding is shown in frequency domain here it is clear that the odd harmonics are suppressed in resistive and inductive grounding.

IV. CONCLUSION

It is observed from the experimental data that for solid grounding fault current is very large and also the odd harmonics are large in magnitude. This large fault current can be limited and odd harmonics can be suppressed by using resistance as well as inductive grounding. Whereas, the grounding of the system depends and varies from the application point of view for the accurate and faster protection solid grounding is required and whereas, for limiting the fault current resistance and inductive grounding is used.

REFERENCES

[1] Zhang Xinyu, Zhao Dan, Yuan JingWei, Du Wei and Wang Yanan*"Characteristic Analysis of Single-phase Earth Fault under Different Grounding Modes of Neutral Point*" IEEE 2018.

[2] M. Vaziri and D. R. Smith "*Grounding of Primary System for LV Networks*" IEEE Transactions on Power Delivery 2013.

[3] Qi Zheng, Zheng Zhao and Yang Yihan*"Study on Method of Single-phase-to-earth Fault Section Location in Neutral Point Resonant Grounded System"* IEEE 2010.

[4] Rahim Jafari, MitalKanabar, Tarlochan S. Sidhu and Ilia Voloh*"Analysis of A Neutral Grounding Resistor Monitoring Method"* IEEE Canadian Conference on Electrical & Computer Engineering (CCECE) 2018.

[5] S. LEVA "*Power Network Asymmetrical Faults Analysis Using Instantaneous Symmetrical Components" J. Electromagnetic Analysis & Applications*, 2009, 1: 205-213.

[6] Chengyong Zhao, YanfenGuo, Gengyin Li "The similitude power detection on single phase to ground fault in the non-solidly grounded system" IEEE/PES Transmission and Distribution Conference & Exhibition: Asia and Pacific Dalian, China 2005.

[7] Yajie Li, Keyan Liu, XiaoliMeng*"A single-line-to-ground fault diagnosis method in small-current--grounding system based on fuzzy-integral decision fusion technique"* China International Conference on Electricity Distribution (CICED 2016) Xi'an, 10-13 Aug, 2016.

[8] S. Ravlić, A. Marušić , J. Havelka*"Neutral Grounding in Middle Voltage Power Systems: Simulation model"* MIPRO 2015, 25-29 May 2015, Opatija, Croatia.