IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 7, July 2021

DOI 10.17148/IJIREEICE.2021.9730

Symmetrical and Unsymmetrical Faults Analysis

Prof. Vishal V. Mehtre[1], Mr. Rahul Keshari[2], Zeeshan Hyder[3]

Department of Electrical Engineering, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, Maharashtra, India[1,2,3]

Abstract: When a short-circuit occurs in a power system, the magnitude of the fault currents, which is very high compared to the steady state current that flows in the power system, is determined by the reactance of the power system equipment (and the reactance of the ground if ground is involved). It is essential that symmetrical and unsymmetrical analysis of the power system network be undertaken to determine the magnitude of these fault currents and fault MVA(Megavolt-Ampere) so as to select adequate ratings of the power system protective devices –such as circuit breakers, relays and fuses. Otherwise, these protective devices will not operate properly in the event of faults thereby causing considerable damage to life and equipment.symmetrical three phase fault is the most severe kind at the transmission lines, while for faults occurring very close to the generating station or synchronous generator, single line to ground fault is the most severe.

Keywords: symmetrical fault, un symmetrical fault, power system, fault analysis

I.INTRODUCTION

3-phase AC power system operating under normal condition has magnitude of both current and voltage equally distributed across each phase. However, fault may occur to disrupt this condition. This fault may be symmetrical (balanced) or unsymmetrical (unbalanced).A symmetrical fault is that which involves all the phases while an unsymmetrical fault involves only one or two phases. Symmetrical and unsymmetrical faults analysis is carried out to determine the value of the fault currents and fault Kilovolt Ampere (KVA) or Megavolt Ampere (MVA) (and also to determine relay settings for each type of fault and hence determine the ratings of the protective relays and circuit breakers to be used in the power system. Such analysis enables the fault MVA due to a symmetrical 3-phase fault at a point of interest to be determined. Also, the current at the point of fault and how it is distributed. This 3-phase AC power system operating under normal condition has magnitude of both current and voltage equally distributed across each phase. However, fault may occur to disrupt this condition. This fault may be symmetrical (balanced) or unsymmetrical (unbalanced). A symmetrical fault is that which involves all the phases while an unsymmetrical fault involves only one or two phases. Symmetrical and unsymmetrical faults analysis is carried out to determine the value of the fault currents and fault Kilovolt Ampere (KVA) or Megavolt Ampere (MVA) for each type of fault and hence determine the ratings of the protective relays and circuit breakers to be used in the power system. Such analysis enables the fault MVA due to a symmetrical 3-phase fault at a point of interest to be determined. Also, the current at the point of fault and how it is distributed. This paper presents an analytic method for the solution of each fault. For symmetrical faults, only one phase is analyzed since the system is balanced that is, the characteristics of the system are the same across all three phases. The result obtained will be the same for the other two phases, hence only one phase needs to be analyzed.

The solution of symmetrical fault analysis consists of:

- Deriving a single line diagram representing one phase of the network.
- Choice of a common base KVA by which all impedance and reactance are converted to per unit values.
- Deriving a single line reactance diagram from the single line diagram
- Finding the Thevenin resistance as seen from the fault point. From this point, the fault current and fault KVA in per unit are determined and then converted to their actual values.

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

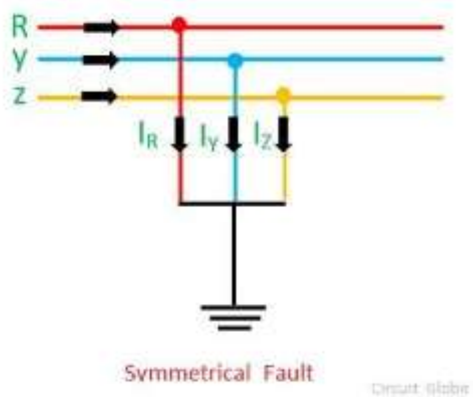
Vol. 9, Issue 7, July 2021

DOI 10.17148/IJIREEICE.2021.9730

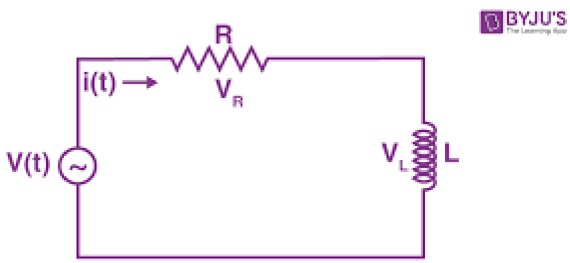
SYMMETRICAL AND UN SYMMETRICAL FAULT

A. Symmetrical Three-Phase Fault Analysis

A symmetrical three-phase fault condition is where either All three-phases of the system are short-circuited to each other or, All three phases of the system are earthed. The faults described above are balanced, hence only positive sequence network is needed to analyze these faults. The behavior of the synchronous generator and transmission line of the power system at the time of symmetrical short-circuit can be studied by modeling these power system components into a Resistance-Inductance (R-L) series circuitA symmetrical three-phase fault condition is where either all three-phases of the system are short-circuited to each other or all three phases of the system are earthed. The faults short circuited or earthed in both conditions this will be balanced, hence only positive sequence network is needed to analyze these faults. The behavior of the synchronous generator and transmission line of the power system at the time of symmetrical short-circuit can be studied by modeling these power system components into a Resistance-Inductance (R-L) series circuit.



Switching Operation in R-L Series Circuit: At the instant when the short circuit occurs, momentary maximum value current flows in the network. This initial maximum value of current at the time of short circuit can be determined by studying the transients in an R-L series circuit which is the most fundamental type of AC circuit.



R-L Series Circuit

B. Unsymmetrical Faults Analysis: Unsymmetrical faults involve only one or two phases. In unsymmetrical faults the three phase lines become unbalanced. Such types of faults occur between line-to-ground or between lines. An unsymmetrical series fault is between phases or between phase-to-ground, whereas unsymmetrical shunt fault is an unbalanced in the line impedances.

Shunt fault in the three-phase system can be classified as;

- Single line to ground fault (LG)
- Line to line fault (LL)
- Double Line-to-ground fault (LLG).
- Three-phase short circuit fault (LLL).
- Three-phase-to-ground fault (LLLG).

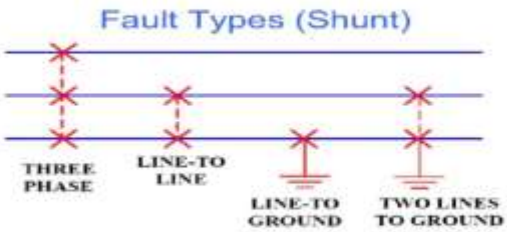
IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 7, July 2021

DOI 10.17148/IJIREEICE.2021.9730



The method of symmetrical components is used to solve any number of poly-phase systems. Dr. D. L. Fortescue proposed in 1918 that any unbalanced system of currents, voltages, or other sinusoidal quantities can be resolved into their balanced system of phasors which are called symmetrical components of the original unbalanced system. Once the problem is solved in terms of symmetrical components, it can be transferred back to the actual circuit condition by super- position or phasor addition of these quantities (currents or voltages) easilyThe method of symmetrical components is used to solve any number of poly-phase systems. Dr. D. L. Fortescue proposed in 1918 that any unbalanced system of currents, voltages, or other sinusoidal quantities can be resolved into their balanced system of phasors which are called symmetrical components of the original unbalanced system. Once the problem is solved in terms of symmetrical components, it can be transferred back to the actual circuit condition by super- position or phasor addition of these quantities (currents or voltages) easily.In single line-to-ground fault, one conductor comes in contact with the ground or the neutral conductor. A line-to-line fault occurs when two conductors are short circuited. A double line-to-ground fault occurs when two conductors fall on the ground or come in contact with the neutral conductor. LG, LL, and LLG are unsymmetrical fault while LLL and LLLG are the symmetrical faults. For this reason, balanced short-circuit calculation is performed to determine these large currents.

Effects of fault: The damaging effect of faults depends upon the type of fault ,as we know short circuit is the most dangerous fault as the current is maximum approximately 10 times the nominal current of instrumentation, given below is the effect:

- Due to heating by fault, electrical equipment like bus bar, generator, transformer are going to be broken & excessive heating of lines, cables may result in fire or explosion.
- Negative sequence current rises from unsymmetrical fault will result in heating.
- Stability of the power system may be adversely affected and can lead to a complete shutdown of the power system.
- Sometimes the short circuit takes the form of arc on an overhead transmission line if not quickly cleared will burn the conductor causing it to break resulting in long time interruption in supply.
- A reduction in the voltage in power system due to a fault sometimes be so large so that relays having pressure coil tends to fail.
- In an industry where we see interconnected system, when a fault develops it is followed by a fall in voltage and frequency, this may result in loads such as motor which normally takes the power from supply will start to feed or deliver the power to fault location. During the fault, induction motor and synchronous motor feed the fault.

Method to overcome faults: To overcome fault in the system we isolate the faulted parts from the rest of the electrical network. Many devices are introduced such as relay, Instrument transformer, circuit breaker, fuses, etc. to provide this isolation of fault. These devices are used for safety purpose, are also accurate and economical.

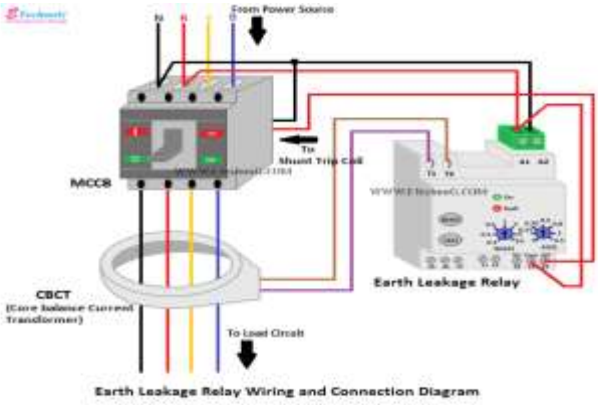
- Relay- It senses the fault and sends the command to circuit breaker for tripping unhealthy parts from healthy parts. It prevents from damages to alternator or to transform. It can handle the high power required to directly control electric motors and other load.

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 7, July 2021

DOI 10.17148/IJIREEICE.2021.9730



- Instrument transformer-It includes current transformer or voltage transformer. It is used to isolate or transform voltage or current level. The most common use of this is to operate instrument or metering device from high voltage or high current circuit.

- Circuit breaker-It is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. It is used to detect fault condition and interrupt current flow.

CONCLUSION

From the above explanation we conclude that due to flowing of current (may be due to switching, short circuit, or lightning) a severe fault may be occur in power system which are described above and we can overcome it by knowing its cause and effect ,so that we can use protecting devices like the relay, circuit breaker, etc. Symmetrical current to be interrupted is computed by using sub-transient reactance for synchronous generators. Momentary current (rms) is then calculated by multiplying the symmetrical momentary current by a factor of 1.6 to account for the presence of DC offset current. In summary, very critical observations are made: for faults along the transmission line far from the generating stations, the magnitude of the symmetrical short circuit current is higher than those for other kinds of faults while, for those short circuits very close to the generating plants, single line-to-ground faults generate the highest magnitude of fault current and fault MVA.

REFERENCES

- B. B. Lame, "The St ory of the Induction motor,"Journal of t he American Institute of Electrical Engineers (JAIEE), vol. 40, pp. 693-716, 1920
- J. B. Gupta, A course in Power Systems, pt. I. New Delhi: S. K. Kataria and Sons, 2013, pp. 1-99.
- C. I. Fortescue, "Method of symmetrical coordinates applied to the solution of polyphase N etworks," American Institute of Electrical Engineers (AIEE) Transactions, vol. 37, part II, pp. 1027-1140, 1980
- J. L. Blackburn, Symmetrical components for Power Systems Engineering, New York: Marcel Dekker, 1993, pp. 193-204.
- E. Clarke, Circuit Analysis for A-C Power systems, Hoboken, NJ: John Wiley and Sons, 1943, pp. 391-400
- J. J. Grainger and W. D. Stevenson Jr. Power System Analysis, New York: McGraw Hill, 1994, pp. 390.
- R. E. Fehr, Industrial Power Distribution, Upper Saddle River, NJ: Prentice Hall, 2002, pp. 71-

