International Journal of Engineering Sciences & Research Technology

(A Peer Reviewed Online Journal)
Impact Factor: 5.164

IJESRT

RESEARCHERID
THOMSON REUTERS

[Gaikwad *et al.*, 9(5): May, 2020]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

BASIC MATLAB SIMULATION OF FAULTS WITHIN POWER SYSTEM

Mr. Sandesh Gaikwad[*1], Mr.Devendra Pawar[2] & Mr.Pankaj Jadhav[3]
[*1,2&3]Dr. Babasaheb Ambedkar Technological University, Lonere, Maharashtra, India

DOI: 10.5281/zenodo.3828927

ABSTRACT

This paper reflect analytical and software study of power system faults. Majority of systems existing today are being computerized, Power system is not the exception to this fact. Hence by Software analysis we can reduce the time as well as the manpower required to determine the location as well as magnitude of faults occurring in electrical power system. This paper basically focus on the applicability of MATLAB simulation tool using which the fault analysis of real time power system structure can carried out. The main type of faults which occurs in power system such as Line to Line(LL),Double Line To Ground(LLG) ,Line To Ground(LG) are briefly discussed along with appropriate MATLAB simulation as well as the mathematical analysis. This paper can work as a fundamental block of much larger applications which involves the solutions developing a stable and efficient power system.

KEYWORDS: Fault analysis in MATLAB, Load flow studies, Faults in power system, L-L –Line to Line fault, Single Line to Ground fault, 2L-G Double Line to Ground fault.

1. INTRODUCTION

The electrical substation which supply the power to the consumers i.e. industries or domestic can have failures due to some faults which can be short-term or long-lasting. Various studies have shown that anywhere from 70%, to as high as 90%, of faults on most overhead lines are transient. A transient fault, such as an insulator flashover, is a fault which is cleared by the immediate tripping of one or more circuit breakers to isolate the fault, and which does not recur when the line is re-energized. Faults tend to be less transient (near the 80% range) at lower, distribution voltages and more transient (near the 90% range) at higher, sub transmission and transmission voltages. These faults lead to considerable damage to the power system equipment. In India it is common to witness the let-downs in supply system due to the faults that occur during the transmission or distribution. The errors might be Line to Ground faults(approximately 65-70%),Line to Line fault(approximately 5-10%) or Double Line to Ground(approximately 15-20%) MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment. A proprietary programming language developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces. The adoption of MATLAB software can enable the computer simulation design and virtual experiment to synchronously implement the design and experiment without the restrictions of components.

Meanwhile, it will facilitate the adjustment and coverage of circuit parameters and realize the updating change of the electric appliance parts, which helps improve the comprehensive design and experiment ability of the students. The simulation is beneficial to cultivate students' thinking and innovation ability, ensure them to master experimental analysis methods on the basis of the grasp of software technology, and boost their study interest. The application of MATLAB software in electricity system modeling. The electricity system belongs to the consumption and production system, including different parts like electricity generating, electricity distributing, electricity consuming and so on In practical work, staff can get the optimal parameters through simulation modeling by MATLAB software. The transformer display incorporates saturation. The parameters have been acquired from reasonable or exploratory estimations. From the study it is seen that sags can create transformer saturation when voltage recovers. This prompts deliver an inrush current that is like inrush current created amid the transformer energizing. The study call attention to that the voltage recovery moment can take just discrete value, since the fault clearing is delivered if there should arise an occurrence of regular current

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

zeros. The moment of voltage recovery compares to the moment of fault clearing. For phase to phase fault and single phase fault, a solitary point-on-wave of voltage recovery can be defined.

Then again for two-phase to-ground and three-phase fault, the recovery happens in a few stages. In petrochemical industry, the establishing and ground fault security are critical factors . For that first it is essential to have the correct framework establishing for the specific framework application, and alongside this it is similarly critical to have the best possible assurance against the ground-fault.

2. FAULTS IN POWER SYSTEM

Faults in power system: mathematical approach
Symmetrical faults - In this type of fault all fault all three phase are simultaneously short circuited hence the network remain balanced.

Unsymmetrical faults – Unsymmetrical faults are the faults which leads unequal currents with unequal phase shifts in a three phase system. The unsymmetrical fault occurs in a system due to presence of an open circuit or short circuit of transmission or distribution line. It includes LG,LLG,LL faults which are discussed below **;**

Line to Ground fault :
In this type of fault 1 phase gets in contact with the ground so potential then becomes infinite.
Boundary condition: I fb =I fc =0
$I f = 3Iao = 3Ea$
$Z0+Z1+Z2+3ZF$
I a0 = I a2 = I a1 .

Line to Line fault :
In this type of fault two phases are short circuited.
Boundary condition: I fa =0. I a0 =0 , I a1 +I a2 =0 & V a1 =V a2
$If = Ia1 = Ea$
$Z1+Z2+ZF$
I a0 = -I a1
I a2 =0

Line to Line to Ground
It is assumed that the fault has occurred at node k of the network. In this the phases b and c got shorted through the impedance Z_f to the ground.
Boundary condition: $3I_{fa} = I_{fb} + I_f$.
$Ia1 = Ea$
$Z1+$
$Z2(Z0+3Zf)$
$(Z0+Z2+3Zf)$
$Ia0 = -Z0+3Zf$
$Ea-Z1Ia1$
$Ia2 = -Z2$
$Ea-Z1Ia1$
I f =3I a0

Faults in power system : a software approach:
A simulation model is developed using MATLAB, to study the behavior of the power system during the normal and faulty conditions. The below figure shows the MATLAB blocks used during the construction of case study

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

of a general power system. The supply to power system is given by a three phase source which can be a alternator in real life condition having voltage rating of 415 V (V_{rms}) at frequency 50 Hz. This voltage is stepped up using a transformer to 11 kV. Pi section of transmission line of 100 km length is developed using a MATLAB Simpower system toolbox. Circuit breakers and relays are used for protection of equipment in the power systems.

Three phase VI measurement block is used to measure the voltage and current of each phase. Scope is used to display the behavior of voltage and current during normal and faulty conditions. To simulate fault in power system a three phase fault block is introduced from SimPower System. A three phase series RLC load is connected to the system having active power requirement of 5 kW.

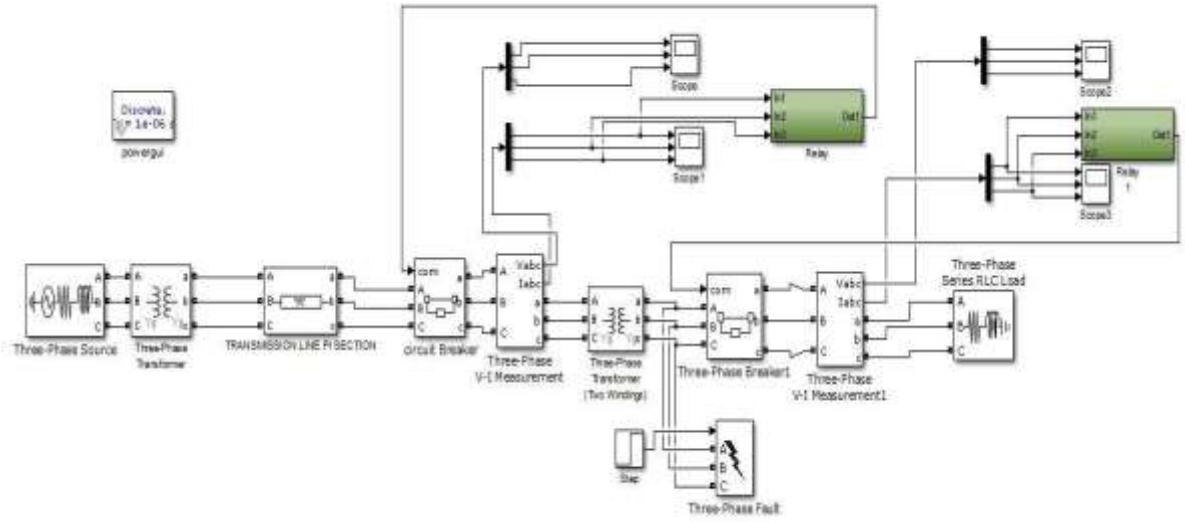


Fig. 1 Simulation model for faults in power system

Faults in power system : a software approach:

Step By Step Procedure On Development Of Circuit Model

1) Start
2) Run the model file (.mdl/.slx)
3) Define CT & PT Ratio
4) Define no. of samples, phases, sampling time(frequency)
5) Define fault & circuit breaker operating times
6) Define system voltage, & line lengths
7) Allocate memory for Current & Voltage data from the three phases
8) Check Max & Min values of Current & Voltage in each phase & if abs(min)>max, abs(min)=max
9) Normalize max Current & Voltage value to 32767 & change matrix to array
10) Separate phase wise Current & Voltage data into different commands
11) Initialize buffer to calculate the trip time
12) Create user defined Current & Voltage waveform
13) Run Test & get the trip status & trip time of the relay
14) Save the generated plots
15) Generate report by creating another server for Excel & passing data from MATLAB to Excel
16) Convert the file into a pdf & save the report
17) End

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Figure 2 indicates the relay circuit sub system for the proposed three phase model in a matlab environment.

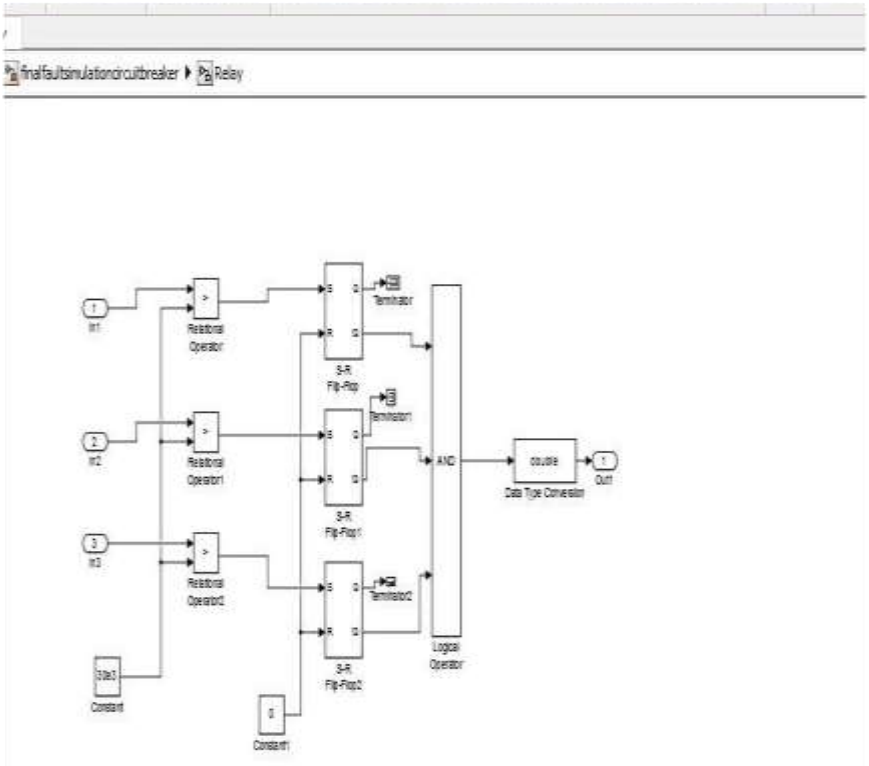


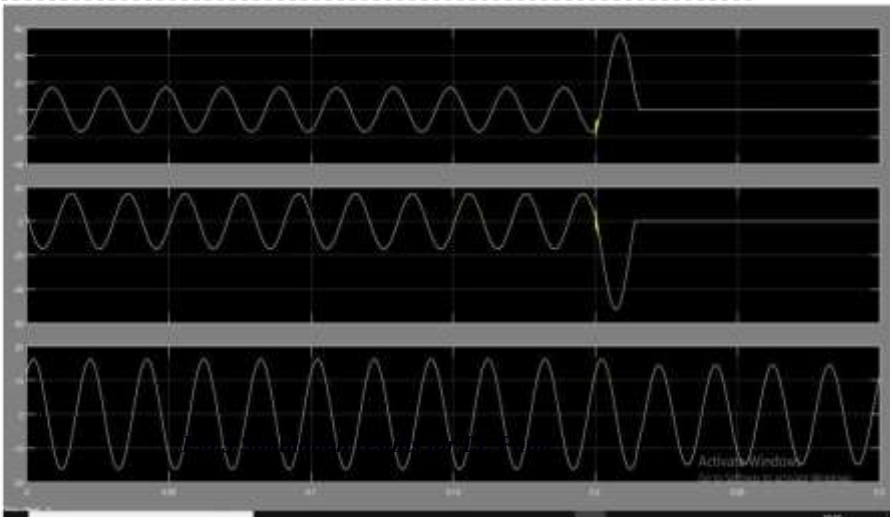
Fig.2. Relay Subsystem

3. RESULT AND DISCUSSION

In this particular case, the Distribution system model is runs for a Three Phase to Ground Fault. The simulation is done for 1 sec, so that the waveforms can be seen more clearly. The sampling frequency is taken to be 10 kHz. The system voltage is taken as 11 kV and the line length is taken as 100 kms,. Fault is started at 0.2 seconds and cleared at 0.216 seconds as shown in Figure. These parameters have been kept constant for other test cases as well. Upon injecting these signals to the relay it has been seen that the relay trips after 0.16 seconds. As this is a self-reset relay, the trip status comes back to 0 upon clearing the fault, but for a manual reset relay, it stays 1 till the reset button is pressed manually. The proposed MATLAB model can be ran standalone or on the GUI to view the plots. Detailed mathematical results for faults in power system is shown in table no. 1.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Fig.3 Simulation results for LG fault



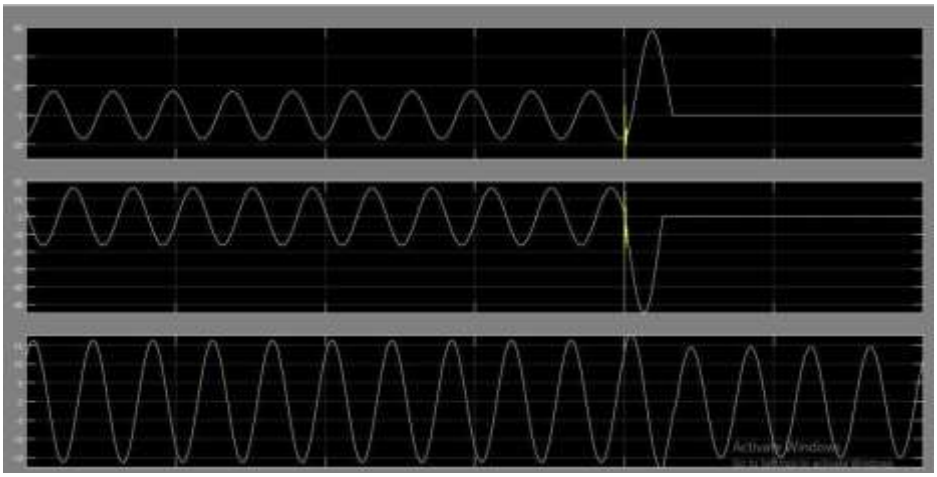


Fig.6 Simulation results for LLG Fault

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Table No.1 Simulation results for faults in power system

For phase	Before Fault				After Fault			
	I_{peak} (A)	I_{rms} (A)	V_{rms} (V)	P_{rms} (kW)	I_{peak} (A)	I_{rms} (A)	V_{rms} (V)	P_{rms} (kW)
Line to Ground Fault								
Phase A	16.2	14.46	2436	14	49.1	28.23	0	0
Line to Line Fault								
Phase A	16.2	14.46	2436	14	55.31	31.58	0	0
Phase B	-16.2	14.46	2436	14	-51.8	30.16	0	0

4. CONCLUSION

In this paper the faults in three phase transmission line are simulated using MATLAB simulation tool. The results obtain from the simulation can be implemented to design a transmission network which is capable of with standing the fault condition for considerable amount of time. Thereby protecting the equipment from the hazardous effects of fault condition. It is a basic simulation which is easy to understand and developed and give appropriate results up to certain limits. This paper also contains mathematical approach towards faults in power system, which gives basic understanding of behavior of transmission line current during fault condition.

5. ACKNOWLEDGEMENTS

We are pleased to present this paper entitled " **Basic MATLAB Simulation of faults in power system"**. , we are greatly indebted to our parents, our family members and our friends without whose blessing and guidance we think we could not have reached this moment in our life.

REFERENCES

[1] C. Vijaya Tharani, M. Nandhini, R. Sundar, Dr K. Nithiyananthan ,"MATLAB based simulation model for three phase power system network", International Journal for Research in Applied Science and Engineering Technology (IJRET),Volume 4,Issue XI, November 2016,ISSN-2321-9653. , 4 th Edition, 1 January 2017, ISBN- 10: 8123914482, ISBN-13: 978-8123914480.

[2] Kenan Hatipoglu, Arash Jamahbozorg and Ghadir Radman, "MATLAB-Based Fault Analysis of Power Systems with Graphical User Interface as an Educational Tool",Southeastcon,2011 Proceedings of IEEE,2011

[3] M.G.Rabbani, A.B.M.Nasiruzzaman, R.I.Sheikh, Md.Shamim Anower, "MATLAB BASED FAULT ANALYSIS TOOLBOX FOR ELECTRICAL POWER SYSTEM",4 th International Conference on Electrical and Computer Engineering(ICECE),December 2006.

[4] Daljeet Kaur, Dr.S.K.Bath, Darshan Singh Sidhu, "Open Circuit Fault Analysis of Electrical Power System Using MATLAB", International Journal of Engineering Research & Technology(IJERT),Vol.3,Issue 3,March-2014. ISSN: 2278-0181.

[5] V. K. Mehta and R.Mehta,"Principles of Power Systems", S.Chand and Company Ltd., New Delhi India,2010