INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK

A POWER SYSTEM FAULT SIMULATOR WITH A GUI

VARUN JADHAV[1], NOAH DIAS[1], ARULSELVAN[2], GANESH PUSHPAKUMAR[2]

1. Electrical & Electronics Dept., Goa College of Engineering, Farmagudi, Ponda, Goa, India- 403401

2. Research & Development Dept., Siemens Ltd., Verna Industrial, Estate, Verna, Goa, India- 403722

Abstract: Simulation of Fault Scenarios on distribution models is very important to study the response of the systems. It also enables the testing of the Protective Relays under these conditions. MATLAB is a tool preferred to create and simulate the model and backend scripting for a GUI which simplifies the work for the user. OMICRON deals with products and services for testing, diagnostics and monitoring of assets. OMICRON modules have very high accuracy in its class of Power System simulators, not only in the steady regions but the transient states as well. If a communication is established between OMICRON and MATLAB the simulation and testing can be made much faster and thus reducing the time of operation. And with a GUI in place, the whole process becomes user friendly. This paper focuses on the GUI made for Fault Simulation on a Distribution Network. The GUI is made robust for different models and is flexible enough to consider many fault scenarios for the real time testing of the protective relays. The GUI has the capability to generate COMTRADE files of the simulations as well, which can be used for further analysis. A report generator is added, which generates a report of the simulation along with the waveforms.

Key Words: Fault Simulations, GUI, OMICRON Power System Simulator, Protective Relays, COMTRADE.

Corresponding Author: MR. VARUN JADHAV

Access Online On:

www.ijpret.com

How to Cite This Article:

Varun Jadhav, IJPRET, 2016; Volume 4 (9): 266-275

PAPER-QR CODE

Available Online at www.ijpret.com

INTRODUCTION

An electric power system is a network of electrical components used to supply, transmit and use electric power. It can be broadly divided into the generators, the transmission system and the distribution system. In such network systems fault localization and isolation becomes crucial for ensuring continuous supply of electricity. Hence the need of high accuracy monitoring and sensing systems has increased. Also, the testing of such protective equipment under the normal working conditions as well as harsh conditions is of a primary importance, which is achieved through Simulations on MATLAB and injection of that data into the protective equipment using a power system simulator like OMICRON CMC 356 [9][10].

The paper is organized in the following manner: Section I: Introduction, Section II: Faults in a Power System, Section III: Material Required, Section IV: The GUI, Section V: Simulation Results, Section VI: Discussion and Section VII concludes the paper.

II. FAULTS IN A POWER SYSTEM

Electrical power systems have a dynamic and complex behavior. Different types of faults can interrupt the healthy operation of the power system. Some of the major electrical faults are phase faults, which include phase to phase faults and phase to ground faults and three phase faults. Electrical faults are a result of the overloads due to the passing current through the conductor being above the permissible value and the faults due to real power deficit occur due to mismatch in the power generated and consumed and result in the frequency deviation and collapse of grid [5][6].

Electrical Phase faults shown in fig. 1 are characterized as:

1. Three Phase Fault.
2. Phase to Ground Fault.
3. Phase to Phase Fault.
4. Phase - Phase to Ground Fault.
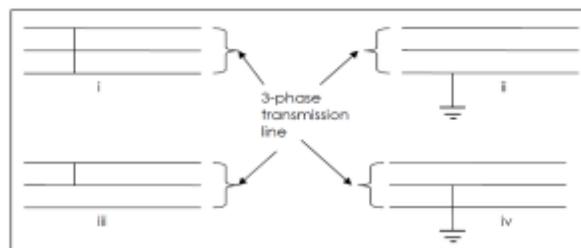
Fig 1: Types of Faults: i. Three Phase, ii. Phase to Ground, iii. Phase to Phase, iv. Phase-Phase to Ground.

III. MATERIAL REQUIRED

A. MATLAB:

Using the SimPowerSystems Library the models are to be created which more or less represent the transient conditions of an actual system. The GUIDE toolbox is used to make the GUI and its backend script is made using an .M file. MATLAB is used as it is a high-performance language for technical computing. It integrates computation, visualization, and programming environment [4].

B. OMICRON CMC 356:

The CMC 356 is a computer-controlled test set for the testing of:

1. Protection relays
2. Transducers
3. Energy meters
4. PQ (power quality) analysers

This is a very accurate power system simulator which not only represents steady state but transient signals also. It has 2 sets of three-phase current outputs and 1 set of three-phase voltage output, and a capability of protection testing with IEC 61850 devices. IEC 61850 is a standard for the design of electrical substation automation. OMICRON's CMEngine Library is used for the backchannel between the device and MATLAB [2].

C. Protective Relay:

A Protective Relay is a device which upon sensing abnormal conditions of the voltage and current, trips the circuit breakers. Relays in general can be classified into the following categories [7]:

1. Directional Relays.
2. Differential Relays.
3. Magnitude Relays.
4. Pilot Relays.
5. Distance Relays.

Over the years the relay technology has developed and the classification based on generations is as follows [8]:

1. Electromechanical Relays: They use the principle of electromechanical conversion. They are rugged & immune to electromagnetic interference. But with recent advancements, they have been turned obsolete in most areas.

268

2. Solid State Relay: They make use of transistors, op-amps, etc. They are more flexible with a self-check facility, consuming less power and having improved dynamic performance than the electromechanical relays. They also were smaller in size requiring less panel space.

3. Numerical Relays: Operation of a numerical relay involves analog to digital conversion of voltage and currents obtained from VT and CTs. These samples are fed to the microprocessor or DSP where the protection algorithms process these signals and necessary decisions are taken. Advantages are:

- Maximum flexibility.
- Multiple functionalities.
- Self check & communication facility.
- It can be made adaptive.
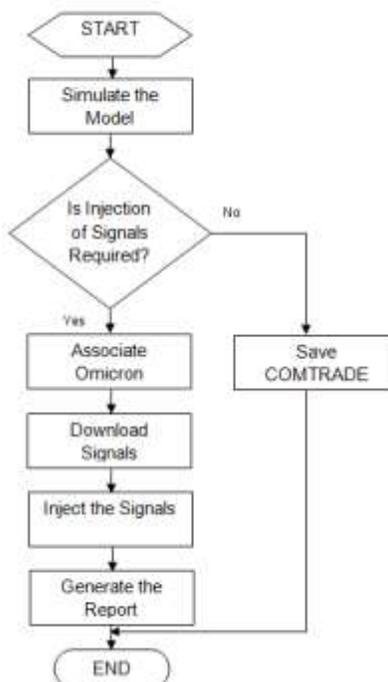
IV. THE GUI
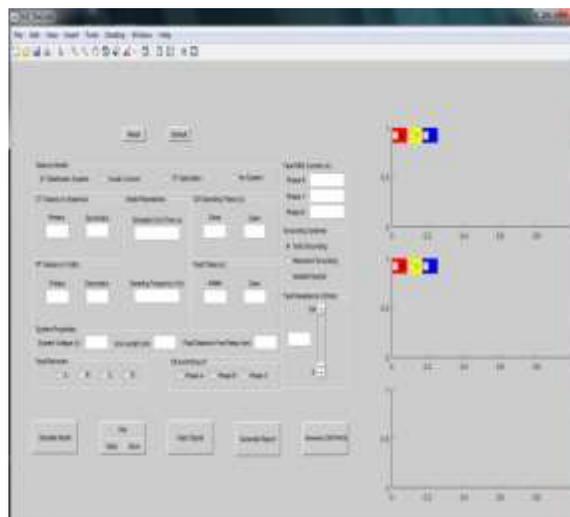
Fig 2: The GUI upon opening

Fig. 2 shows the GUI. The GUI is controlled with a backend script containing the OMICRON controls [1][2][3][4].

A. Features of the GUI:

1. Test Cases can be added.

2. Range selectivity can be increased by enabling or disabling parameters resulting in multiple test cases.

3. Phase selectable waveforms, linked time axes along with zooming and panning options provide a platform for comparative analysis.

4. Error handling is incorporated with a status bar showing cause of errors.

5. Default values of embedded models are programmed which enables a user to directly simulate using default data.

6. Reset button is provided if a fresh test case is desired, thus avoiding the reopening process.

7. The length of the line and setting of the distance of the fault can be defined and thus can be used to analyze the reach of the relay.

8. The GUI has buttons for "Simulate Model", "Plot", "Inject Signals". "Generate Report" and "Generate COMTRADE" which are sequential and improve functionality, which allows the user to use the GUI and choose or not to view plots, inject signals, generate the reports or COMTRADEs.

9. The COMTRADEs and Reports are date-time stamped which allows the user to identify the test results and eliminating overwriting of data.

10. From the third plot we can analyze trip status and trip time, the time of the relay contacts staying high and thus the effectiveness of the relay.

11. The provision for testing of the models for different grounding systems is given thus enabling more test cases.

12. Fault currents on each phase can be viewed on the GUI upon simulation.

B. Flowchart to Run the GUI:

Fig 2: GUI Flowchart

V. SIMULATION RESULTS
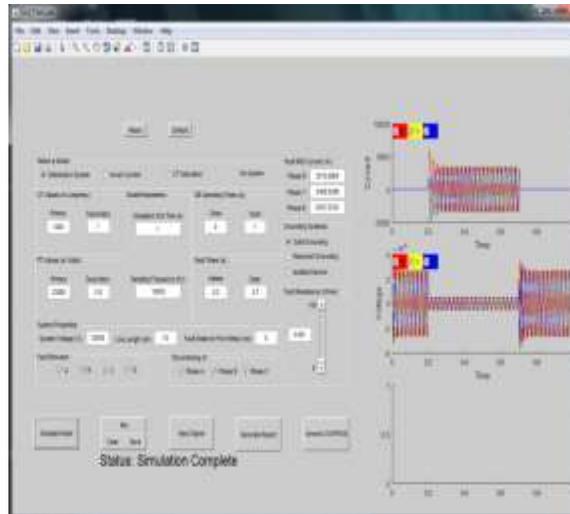
This is how the GUI looks upon running:

Fig 3: The GUI upon running
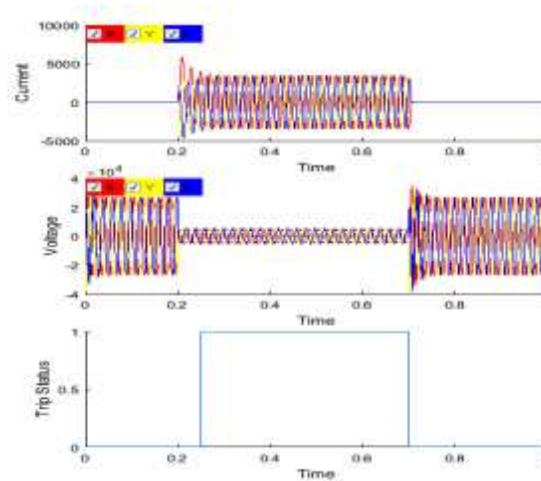
A.   Test Cases:

1) Three Phase Fault:
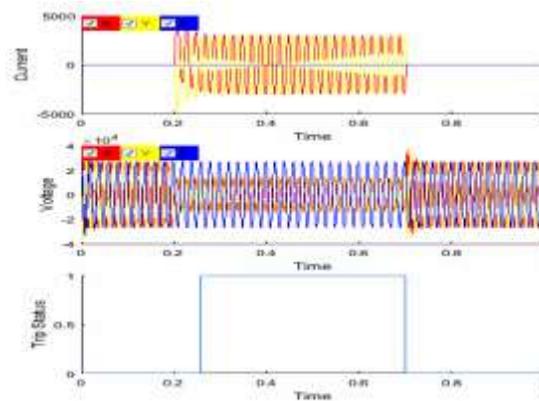

Fig 4: Test Case RYB

2) Phase to Phase Fault:

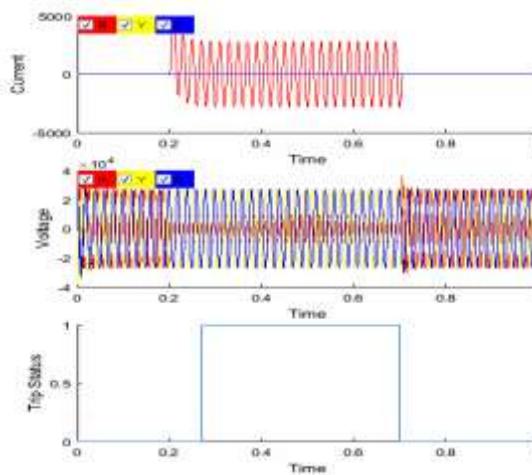**Fig 5: Test Case RY**

3) Phase to Ground Fault:

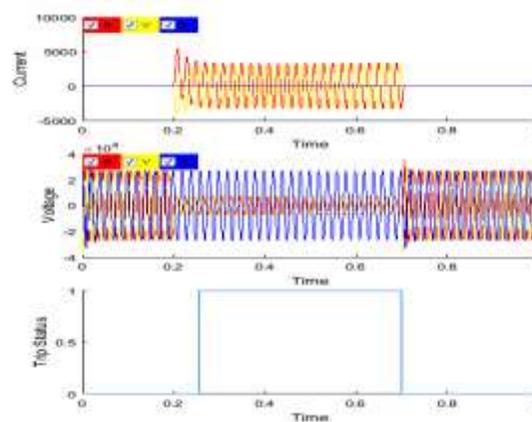**Fig 7: Test Case RG**

4) Two Phase to Ground Fault:

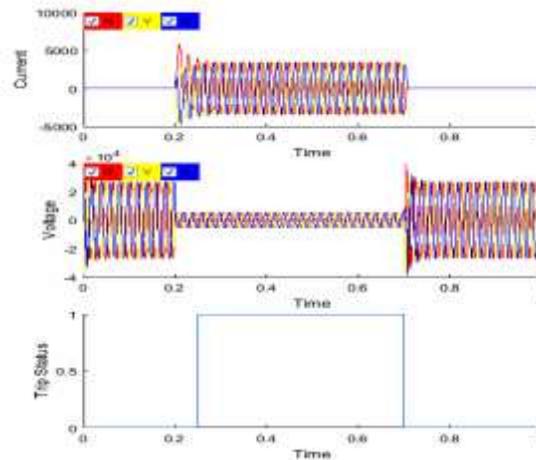**Fig 8: Test Case RYG**

5) Three Phase to Ground Fault:

Fig 9: Test Case RYBG
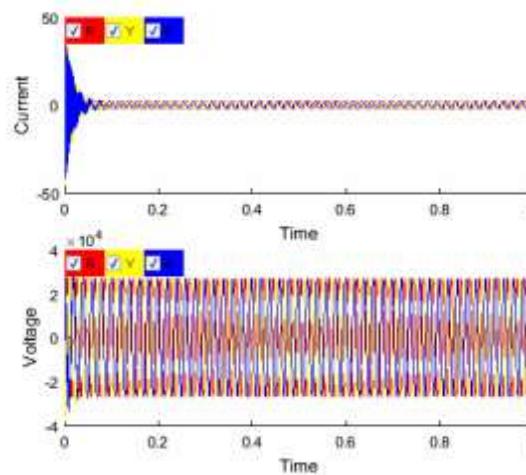
6) No Fault:

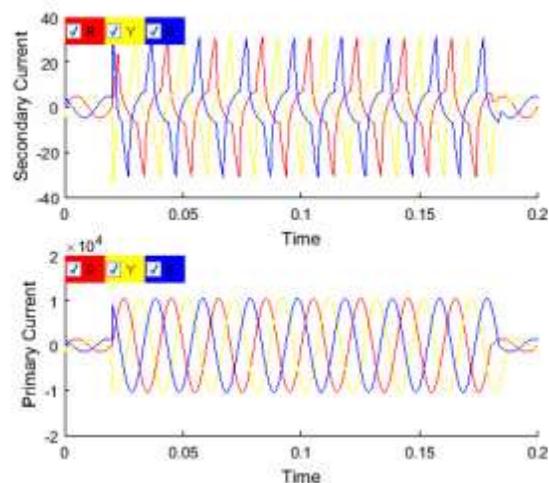**Fig 10: Test Case No Fault**

7) CT Saturation:
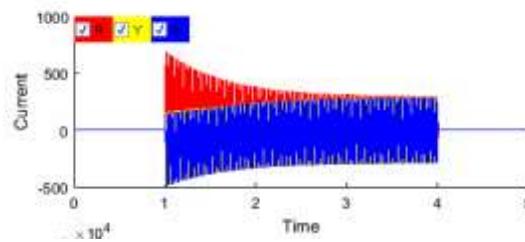
Fig 11: CT Saturation

8) Inrush:

Fig 12: Inrush

VI. DISCUSSION

1. The simulation is done for three models embedded in the GUI.

2. We see that the simulation is done for a small time period; this is only to show the waveforms more clearly. The sampling frequency chosen is 10 kHz, for high accuracy.

3. From fig. 4, where the GUI has run already we have the current and voltage waveforms for the given specifications, which are then blown up and shown for other test cases.

4. Once simulation ends the signals are injected to the relay via the OMICRON module. We see that the relay trips after 47.51 ms and the trip status is shown in the final graph of fig. 4.

5. If the chosen relay is configured to reset upon fault, the trip status comes back to 0 upon clearing the fault as in this case, whereas for a manual reset relay, the status will be 1 till the reset button is pressed manually.

6. From the test cases we see that the GUI is able to simulate all kinds of faults on the line and test the relay accurately giving the trip status and the trip time.

274

CONCLUSION

The GUI is successful in running all the test cases, and thus proving its robustness. The GUI has effectively lowered the complexity of the testing for the user. Further modifications in the GUI are in progress to make it run for all models fulfilling the base requirements.

REFERENCES:

1. ANSI/IEEE C37.111.1991 Standard Common Format for Transient Data Exchange (COMTRADE) for Power Systems

2. OMICRON CMC 356 User Manual

3. OMICRON CM Engine® User Manual

4. MATLAB Documentation, www.mathworks.com

5. Md Asaduzzaman Nur, Mehdi Hasan Sourov, M S Muhit, Md KhaledvHossain, "Fault analysis and Electrical Protection of Distribution System", Global Journal of Researches in Engineering, Volume 14, Issue 3, Version 1.0, 2014

6. M. Kezunovic, G. Latisko, M. Knezev, T. Popovic, "Automation of Fault Analysis: Implementation Approaches and Related Benefits," International Conference on Electrical Engineering, ICEE 07, Hong Kong, July, 2007.

7. Suhaas Bhargava Ayyagari, "Artificial Neural Network Based Fault Location For Transmission Lines" University of Kentucky, Master's thesis, online

8. NPTEL lectures, "Power System Protection", S.A. Soman, IIT Bombay

9. https://en.wikipedia.org/wiki/Power-system_protection

10. https://en.wikipedia.org/wiki/Electric_power_system