AMERICAN INTERNATIONAL UNIVERSITY BANGLADESH

Faculty of Engineering

Laboratory Report Cover Sheet

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Please submit all reports to your subject supervisor or the office of the concerned faculty.

Laboratory Title: __ **Design and fault analysis of a 3-5 bus system**

Experiment Number: **OEL** Due Date: **11-12-2021** Semester: **FALL 2021-2022**

Subject Code: Subject Name: **Power System Analysis** Section: **B**

Course Instructor: **ANAS ABDULLAH ALVI** Department: **EEE**

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Title: Design and fault analysis of a 3-5 bus system.

Abstract: The objective of this experiment was to design a power system network consisting of 3 bus arrangement which represent a true power system scenario so that the fault analysis could be done to check the system performance.

Introduction: Fault is a very common issue in power system network. Short circuits are usually called "faults" by power system engineers. Faults are caused either by insulation failures or by conducting path failures. The failure of insulation results in short circuits which are very harmful as they may damage some equipment of the power system. Most of the faults in transmission and distribution lines are caused by over voltages due to lightning or switching surges, or by external conducting objects falling on overhead lines. Overvoltage due to lightning or switching surges cause flashover on the surface of insulators resulting in short circuits. Short circuits are also caused by tree branches or other conducting objects falling on the overhead lines. There are basically two types of faults: symmetrical and unsymmetrical. The symmetrical fault occurs when all the three conductors of a three-phase line are brought together simultaneously into a short–circuit condition. This type of fault gives rise to symmetrical currents i.e., equal fault currents with 1200 displacement. Because of balanced nature of fault, only one phase needs to be considered in calculations since condition in the other two phases will also be similar. On the other hand, unsymmetrical faults can be classified in 3 types: Line to Line, Line to Ground, Double line to Ground. The fault impedance being low, the fault currents are relatively high. The fault currents being excessive, they damage the faulty equipment and the supply installation. Also, the system voltage may reduce to a low level, windings and bus bars may suffer mechanical damage due to high magnetic forces during faults and the individual generators in a power station or group of generators in different power stations may lose synchronism. That is why the fault must be analyzed to ensure the appropriate selection of power system protective equipment.

Equipment: MATLAB™ Simulink™

Required power system network blocks:

- Three-Phase source
- Three-Transformer (two windings)
- Three-Phase series RLC branch
- Three-Phase parallel RLC branch
- Three-Phase parallel RLC load
- Three-Phase fault
- Three-Phase V-I measurement
- Scope
- Powergui

Methodology: The decision was made that the designed power system network would be a 3-bus bus arrangement. To setup the power system network on Simulink at first, we collected all the necessary block mentioned above from library browser. The 3-Bus Power System Network was constructed like the figure given below.

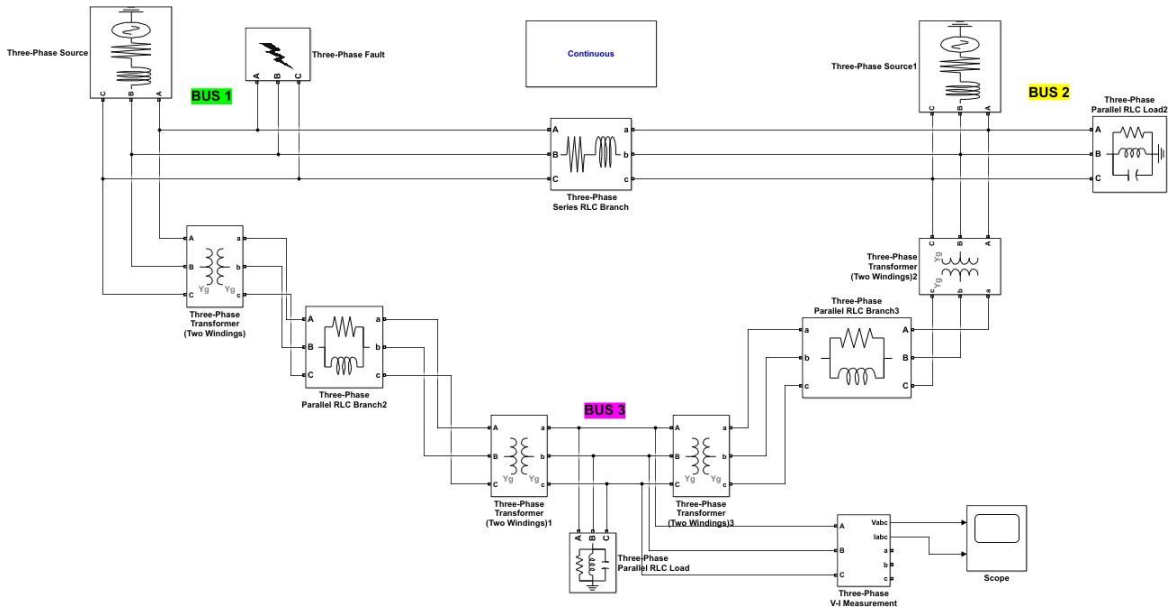


Fig 1: Set up of 3-Bus Power System Network for fault analysis

After setting up the power system network, each block was modified accordingly.

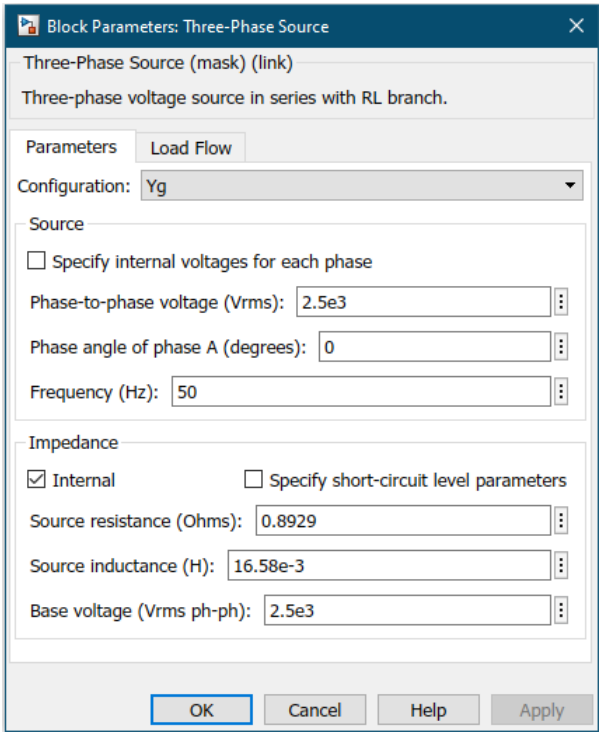


Fig 2: Three-Phase source block modification.

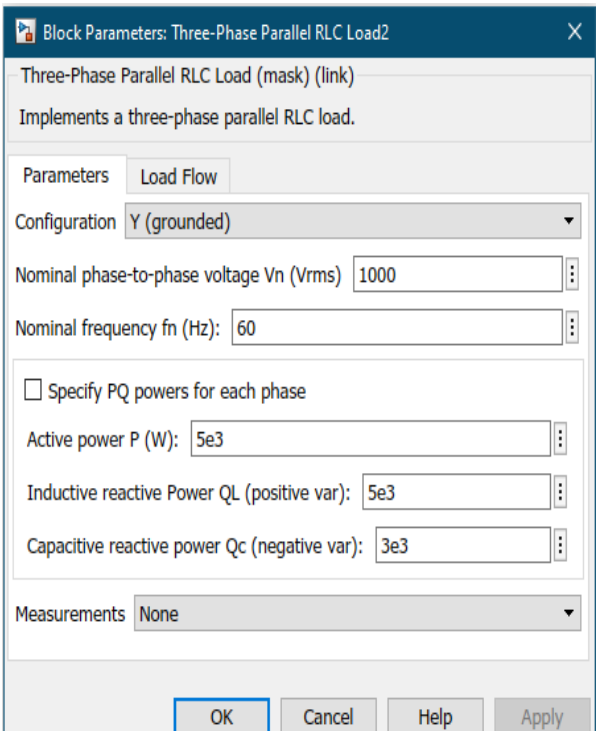
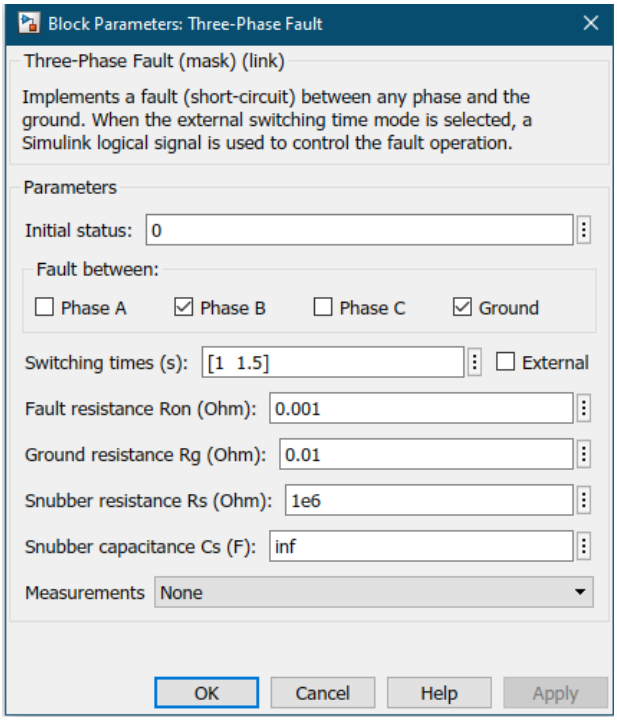


Fig 3: Three-Phase parallel RLC load block modification.



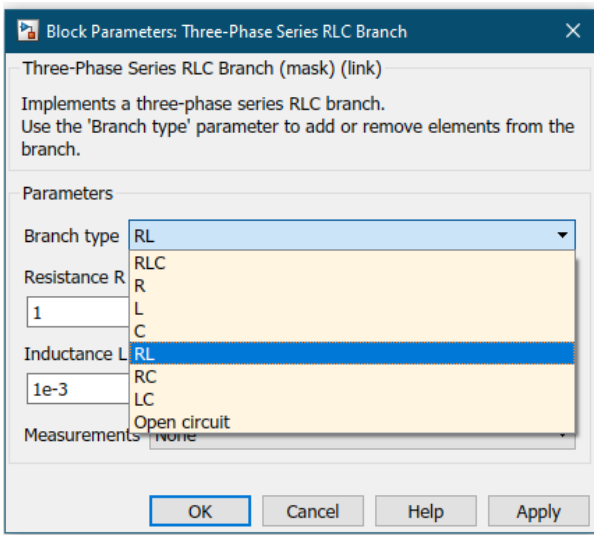


Fig 5: Three-Phase parallel RLC brach block modification.

Fig 4: Three-Phase fault block modification.

A single-phase line to ground fault was created at Bus 1 and as an effect of this fault voltage and current was calculated at Bus 3.

Simulation:

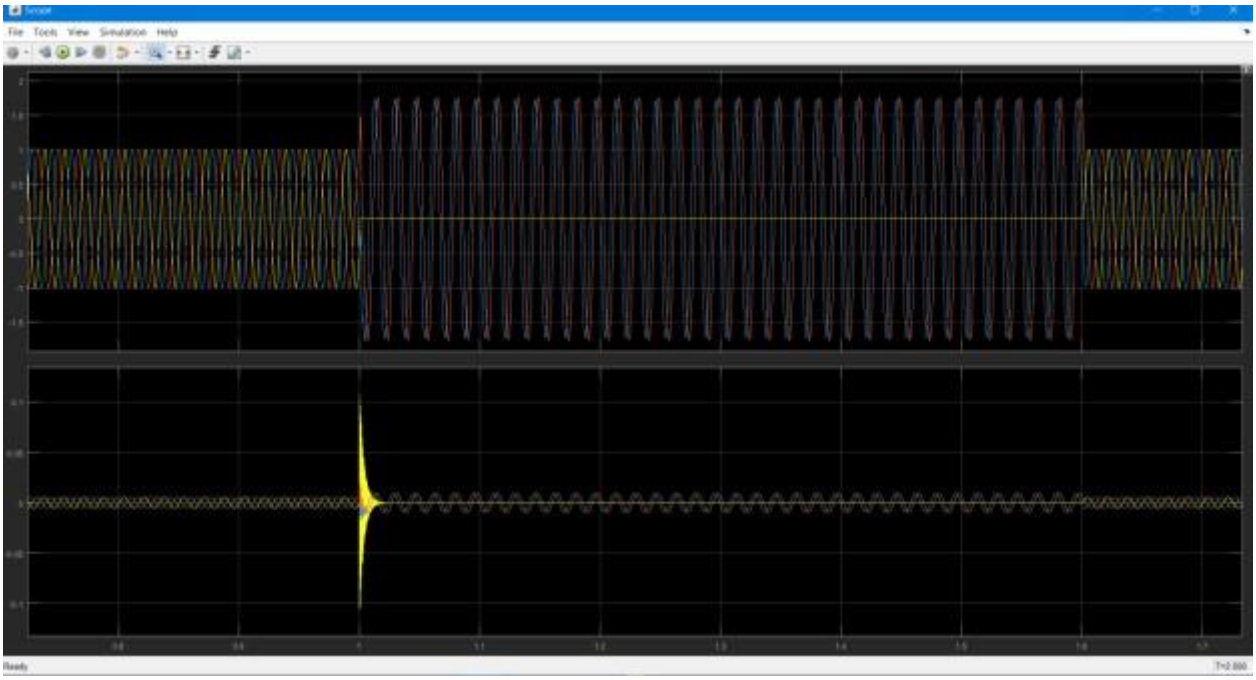


Fig 6: Three-Phase V-I measurement and fault analysis

Result analysis: In this power system network setup a single phase to ground unsymmetrical fault was occurred intentionally to analyze the fault for 1 second to 1.6 seconds. From the above figure when the time is exactly 1 second fault has occurred, and the amplitude of the voltage waveform has decreased to 0 and it remained 0 until 1.6 seconds. On the other hand, if we observe the waveform of current, we will also see that the amplitude of the current waveform has suddenly become 0 and remained unchanged until reaching 1.6 seconds. Therefore, we can say that the power system network represents a real-life power network system where faults can be easily analyzed. The powergui block should have been turned into discrete but we couldn't do that due to our lacking of Simulink knowledge but yet we got the result that is quite good and understandable.

Discussion and conclusion:

In this experiment we were asked to design a power system network consisting of 3 to 5 bus arrangement which represents a true power system scenario. All the freedoms were provided to select suitable equipment for the network but must be a feasible system design. And the fault analysis must be done to check the system performance. According to the requirement we planned to design a 3-bus power network system. A 3-bus power system network was constructed and at bus 1, single phase to ground – unsymmetrical fault was created for 1.6 second duration. During this time using the three-phase measurement block and scope the fault was analyzed. The aim of designing a power system network was to ensure uninterrupted power flow through the system specially across the load. Also, the design was done in such a way so that all the equipment in the network carries rated amount of electricity without overheating and mechanical damage. Fault is a very common issue in power system network. That is why the fault must be analyzed to ensure the appropriate selection of power system protective equipment. Maximum fault current and duration of fault in the system was also analyzed. Since a power system network was designed, fault analysis was performed, then the result was analyzed and the investigation was discussed in detail therefore, it can be said that all the objectives of this experiment have been fulfilled and the experiment is successful.

Reference:

[1] I J Nagrath, D P Lothari, "Modern Power System Analysis, Second Edition, Tata McGraw-Hill Publishing Company Limited.
[2] Introduction to MATLAB by Rudra Pratap
[3] MATLAB User Manual by MathWorks