International Journal of Science and Engineering Applications
Volume 7–Issue 11,474-478, 2018, ISSN:-2319–7560

Modelling and Simulation of Protection for Power Transformer at Primary Substation by Using Differential Protection

Pyone Pyone Aye
Department of Electrical Power Engineering, Technological University (Thanlyin), Myanmar

Win Kyaw Myint
Department of Electrical Power Engineering, Technological University (Thanlyin), Myanmar

Win Thu Zar
Department of Electrical Power Engineering, Technological University (Thanlyin), Myanmar

Abstract: The word "Protection" is used to describe the whole concept of protecting a power system. Transformer protection is the vital significance to provide reliable operation of power system. The main challenge in transformer protection is to find a fast and efficient differential relay algorithm that isolates the transformer from the system causing least damage. Digital differential protection is a developed idea of the old system of conventional differential protection, which had made perfect solution to the problems that the old system suffer. In this paper, differential protection using relay is presented. MATLAB/SIMULINK platform were used to analyze differential protection relay for a large power transformer.

Keywords: Power Transformer, Transformer Differential Protection, Substation, MATLAB/SIMULINK

1. INTRODUCTION

Power transformers are the most important equipment in substation and power stations. Thus protection of the power transformers are vital important for proper operation of power system. Among various power transformer operations, the differential operation is the most common method. In this paper, the differential protection of 230/33/11 kV transformer of Thanlyin substation is studied using MATLAB/SIMULINK. The contents of each designed block are illustrated in separate figs. 7 to 14.There are some coefficients are kept hidden for the reader to find them. These coefficients can change the behavior of the design.

2. POWER TRANSFORMER

Power transformer is a static piece of apparatus with two or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of voltage and current usually of different values and at the same frequency for the purpose of transmitting electrical power." (Definition of Power Transformer; taken from IEC 600761 standard).Power transformer is one of the most important components in power system, for which many kinds of protective and monitoring schemes have been developed for many years. A power transformer is a very expensive electrical device, and its operation directly affects the performance of other equipment to which it is connected.

3. Differential Protection for Power Transformer

Differential protection is applied on busses, generators, transformers, and large motors. Specialized relays exist for each of these applications, and their settings are described in the manufacturer's literature. Differential relays require careful selection of current transformers. The full winding should be used when multi ratio CTs are used in differential schemes, and other relays and meters should be fed from different CT circuits. Transformer differential protection requires CTs with limited mismatch. Generally, differential protection is applied to transformer banks of 10 MVA above. The key is the importance of the transformer in the system, differential may be desirable for smaller units to limit damage in critical interconnections. The fundamental operating principle of transformer differential protection is based on comparison of the transformer primary and secondary winding currents. For an ideal transformer, having a 1:1 ratio and neglecting magnetizing current, the currents entering and leaving the transformer must be equal. The differential relay actually compares between primary current and secondary current of power transformer, if any unbalance encountered in between primary and secondary currents the relay will actuate and inter trip both the primary and secondary circuit breaker of the transformer as shown in Fig (1).

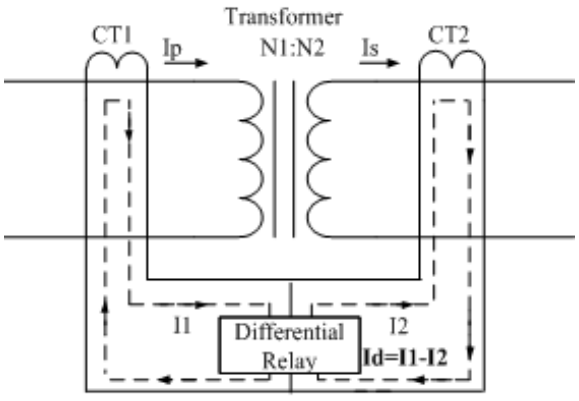

Figure.1 Differential Protection for Single-Phase Two Winding Transformer

Basis of the conventional percentage differential relay is that the differential current (I_d) is more than a predetermined percentage of the restraint current (I_r) is shown in Fig (2).

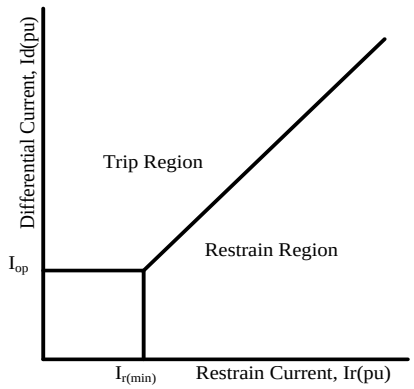

Figure.2 Percentage differential relay characteristics

4. Study on Power Transformer at 230/33/11 kV Thanlyin Primary Substation

The substation is an assemblage of equipment for the purpose of switching, regulating and changing the level of supply voltage from transmission level to primary distribution level. Fig (3), (4) and (5) are denoted by the necessary equipment for power transformer differential protection in Thanlyin Substation

Figure .3 Three Single- Phase Transformer in Thanlyin Primary Substation

Figure.4 Current Transformer for 230kV side

Figure.5 Differential Relay using for Thanlyin Substation

5. Modelling For Differential Protection of 100MVA, 230/33/11kV Transformer

Figure.6 illustrates Matlab/Simulink Model of the proposed system. Since the transformer under study is connected in YY connection, the primary and secondary CTs are connected in delta connections. The single line to ground fault is applied at low tension side of the power transformer. All CTs are connected to differential relays connected as shown in figure. The differential relay block contents is shown in Figure 7. The comparator block contents, the amplitude comparator block contents, the harmonic comparator block contents, and the ratio block contents are shown in Figure 8 through Figure 11. The current transformer block diagram is shown in Figure 12. The current transformer turn ratio is set as 300/1 as in actual condition. The burden is selected as 30 VA.

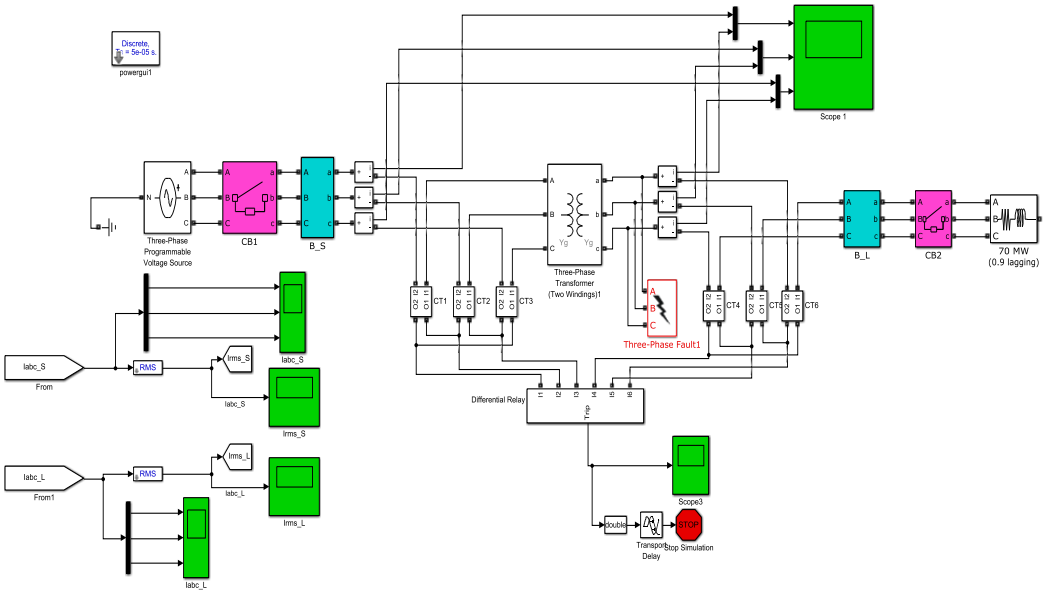

Figure.6 Matlab/Simulink Model of the proposed system

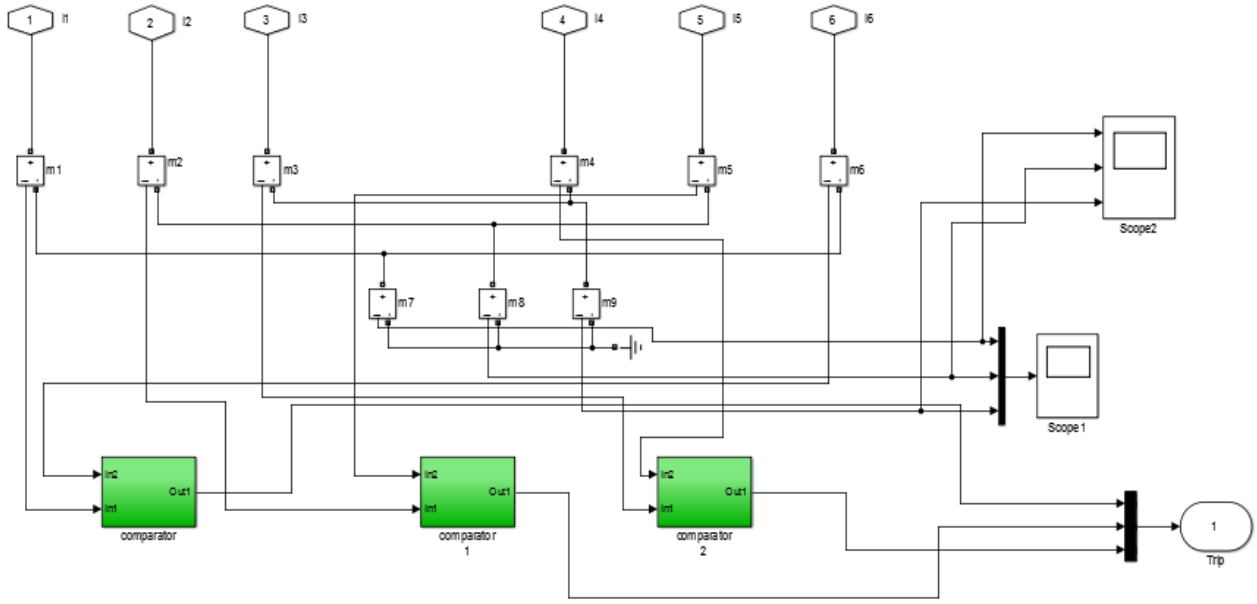

Figure.7 The differential relay block contents

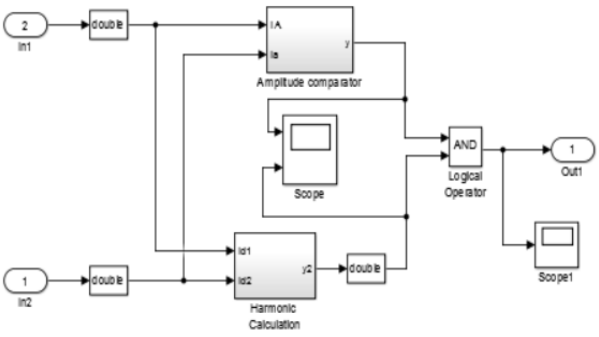

Figure.8 The comparator block contents

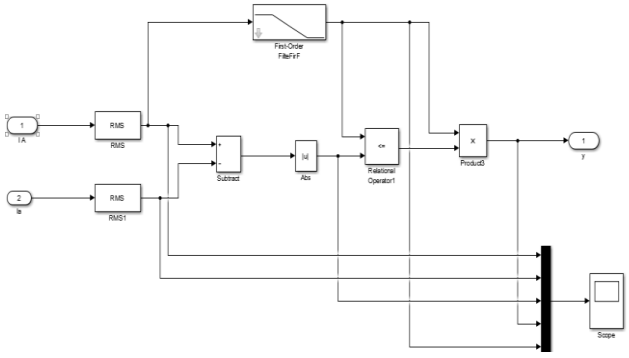

Figure.9 The amplitude comparator block contents

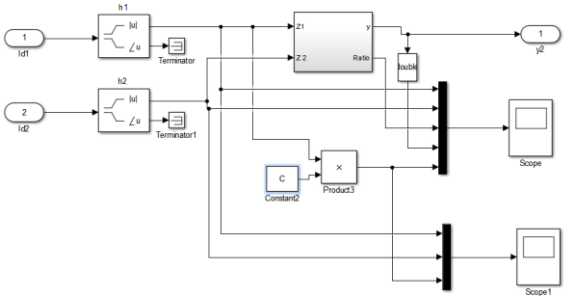

Figure.10 The harmonic comparator block contents

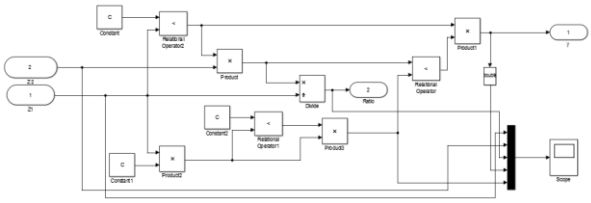

Figure.11 The ratio block contents

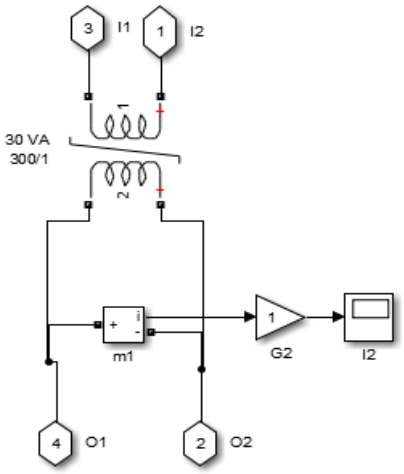

Figure.12 Current transformer block contents

6. SIMULATION RESULTS

To analyze the performance of designed differential relay, phase 'A' to ground fault is applied at low tension side of transformer. The fault duration is set as 2 second to 2.1 second. The simulation results are shown in the following figures. Ths results consists of trip signal, source currents, and load currents. As the fault occur at 2 second, the trip signal become one, i.e. sent signal to breaker to turn off. Thus, after some time delay, breakers are trip and simulation is stop as shown in Figures.

At the source side, phase 'A' currrent is increased and phase 'B' and 'C' currents are decreased. At the load side, phase 'A' current is very reduced and phase 'B' and 'C' currents are slightly reduced as shown in Figure 15. In all aspect, The designed differential relay work properly and protect the transformer effectively.

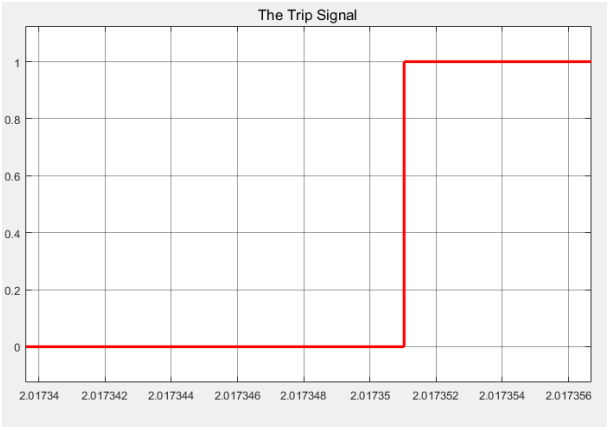

Figure.13 Zoomed trip signal,trip time is around 2.02 sec

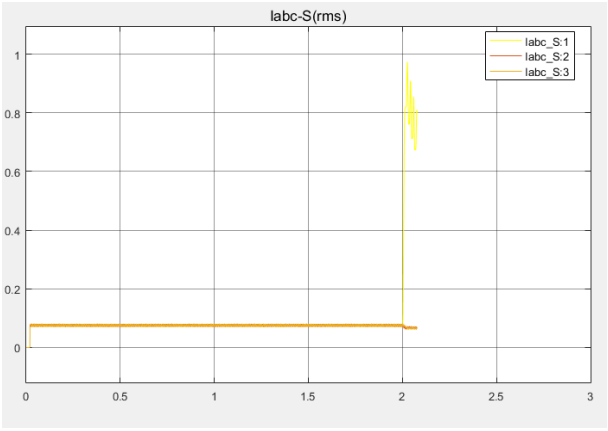

Figure.14 Simulation results for three-phase source currents

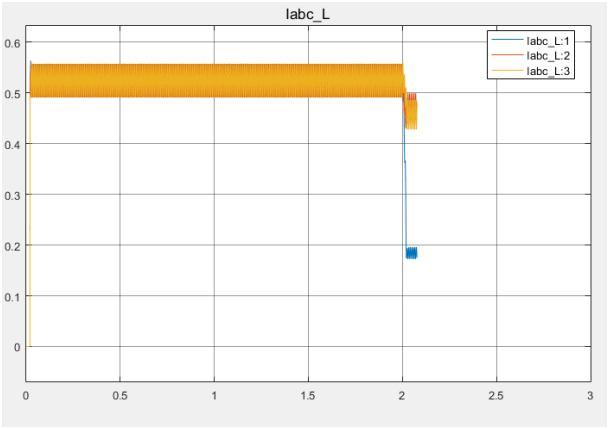

Figure.15 Simulation results for three-phase load currents

7. CONCLUSION

In this paper, modelling and simulation of differential protection for power transformer at primary substation is presented.The detailed studied is carried out at 230/33 /11kV Thanlyin Primary transmission substation. The implementation is shown in step by step. This simulation is tested for various cases and for all cases it gave satisfactory results. There are some difficulties are faced in the implantation of this system such as the lack of some toolbox in the Sim-power-system. For example there is no current transformer in the toolbox. To solve this case, by using a

regular single phase and make some changes in its specifications to fit the current transformer specifications. The complete differential relay design model is presented in this paper. According to simulation results, the designed model work correctly and simulation results are quite reliable.

8. ACKNOWLEDGEMENTS

The author is deeply grateful to her dissertation superior and co-supervisor. The author also thanks to all teachers at Technological University (Thanlyin) and all who provided her with necessary assistance for this paper. The author wishes to express her guidance to all persons who helped directly or indirectly towards the successful completion of paper. Finally, the author wishes to express her special thanks to her parents for their support and encouragement to attain her destination without any trouble.

9. REFERENCES

[1] P.M.,"Power System Protection", Piscataway, NJ: IEEE Press, 1999.

[2] Thin Le Yee,"Design Criteria on Substation Protection by using Instrument Transformers" Department of Electrical Power Engineering (M.T.U), GMSARN International Conference on Sustainable Development; Issues and Prospects for the GMS, 12-14 Nov.2008.

[3] Adel Aktaibi and M. Azizur Rahman"Digital Differential Protection of Power TransformerUsingMatlab"Memorial University of Newfoundland, Canada.

[4] M.S.EI-Bages"IMPROVEMENT OF DIGITAL DIFFERENTIAL RELAY SENSITIVITY FOR INTERNAL GROUND FAULTS IN POWER TRANSFORMERS" Electrical Engineering Department ,Faculty of Engineering ,Benha University, cario, Egypt ISSN 2077-3528, Issue 8, Volume 3, Sep.2011