MANTECH Publications
Journal of Power Electronics and Drives
Volume 7, Issue 1, January-April 2022

A Study on Power Transformer Protection Scheme with Differential Protection

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Abstract

Differential protection relays are often used to protect power transformers. Differential protection is the primary safeguard for power transformers against internal defects. External faults have the same impact on the two sets of differential protection current transformers. When an external problem affects only one set of current transformers, differential protection fails and erroneous tripping occurs. This document explains how to safeguard any three-phase power transformer with standardised, current-based differential protection. The major goal of this research is to evaluate whether typical three-phase power transformers may benefit from differential protection.

***Keywords**: Fault condition, Power transformer, Differential protection, MATLAB Simulink Software*

INTRODUCTION

A power transformer is a static piece of equipment having at least two windings that, using electromagnetic induction, converts one system of voltage and current into another system of voltage and current of varying values and frequencies in order to convey electrical power.

Internal failures in transformers can occur when the winding insulation deteriorates due to overheating or mechanical failure. When a transformer has an internal problem, it must be withdrawn from the system as soon as possible since a protracted arc in the transformer might trigger an oil fire. Differential protection is one of the most effective ways to safeguard power transformers.

On the primary and secondary sides of the power transformer, the differential relay compares the currents recorded by the current transformers. The current entering the transformer under normal conditions is equal to the current exiting it, according to this design. If there is a differential current, the relay will generate a trip signal that will trip both circuit breakers on the primary and secondary sides of the power transformer at the same time.

LITERATURE SURVEY

Elimination of Zero Sequence Currents Effect on Differential Protection for Power Transformers Connected to Power Grid was presented by Ahmed Maged Ismail et al. ZSC and the parameters that impact its values are analysed and simulated to avoid differential protection from tripping.

Improvement of Transformer Differential Protection Security in Breaker-and-a-Half Substations was given by Peyman Jafarian and Ali Agheli. If the transformer winding current is provided by paralleling the bay CTs, this article aims to investigate the reason of spurious tripping of the transformer low-impedance differential protection in breaker-and-a-half substations.

Gagandeep Sharma, Harjit Singh Kainth A new approach for differential protection in power transformers was presented. The three phase current on both sides of the transformer was measured using the proposed approach.

Microcontroller Based Differential Relay with Fuzzy Logic for Transformer Protection was given by Madhura S. Deshmukh and V.T. Barhate. The CTs were used to measure the differential current and restraining current.

Vijay H Makwana, Pooja N Upadhayaya In a laboratory setting, I presented Modeling and Simulation of a Transformer Biased Differential Protection Scheme. MATLAB/SIMULINK was used to determine transformer parameters utilising open circuit and short circuit tests.

APPROACH

The differential protection approach, which employs differential relay circuits, is one of the most effective ways to safeguard power transformers. This strategy is based on the principle that the power input to the transformer is equal to the power output under normal conditions.

Under normal situations, no current will flow into the relay coil if the secondary's of current transformers are properly connected.

When a problem occurs, the current balance will be disrupted, and relay contacts will close, sending a trip signal to particular circuit breakers, causing them to trip and disconnect the damaged equipment[1]. The Power Transformer security strategy should be designed to prevent and block differential relay tripping during magnetising inrush and over excitation, as well as to quickly operate the relay tripping during interior difficulties.

As a result, an appropriate differentiating proof plan that can identify and discriminate the magnetising inrush over excitation and internal fault current is required. Differential defensive relays with a percentage constraint have been in use for many years.

As seen in Figure 1 below. This is a basic simulation circuit made with MATLAB Simulink. Three phase fault is coupled to three phase series RLC load, as well as distribution line characteristics and Three Phase Induction Matrix type transformer (three winding).

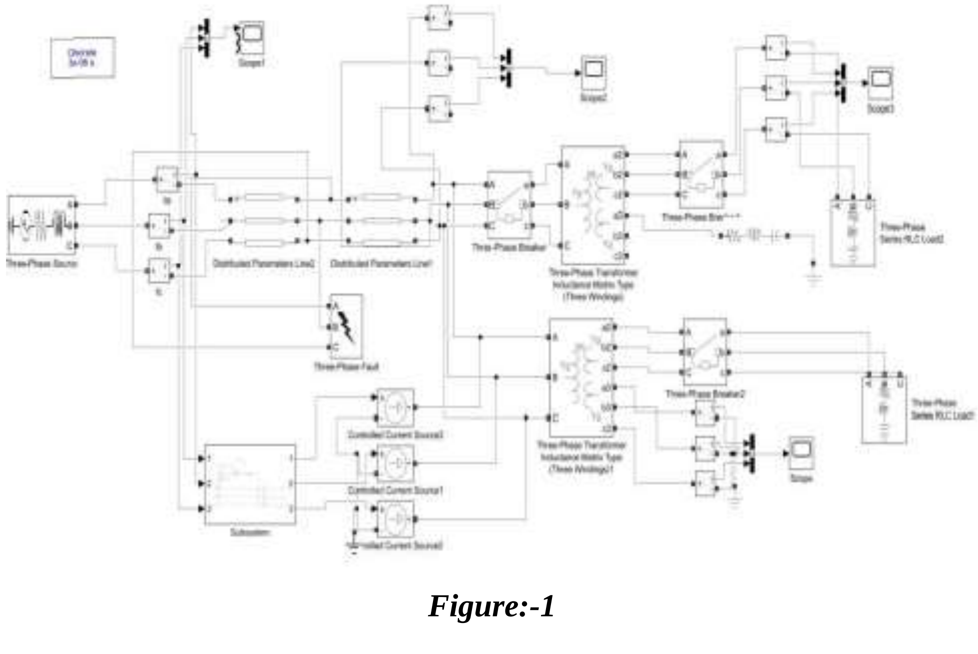

Figure:-1

On either side of the transformer, a three-phase breaker is used to break the circuit, which is initially open. The three phase fault block is used to produce the LLLG fault. With a frequency of 50 Hz, a phase to phase RMS voltage supply of 25 KV is supplied as an input.

Initially, a transmission line with a length of 1 km was employed, and then it was gradually enlarged to test different outputs for different transmission line lengths. To imitate MATLAB Simulink, a three phase fault block is used to produce an LLLG fault with a fault resistance of 50 ohm. [6-8]

The value of zero sequence current (ZSC) should be determined online in order to remove it from the differential protection system (not pre-set one). Equation 1 may be used to calculate this value per phase.

I(ZSC)= (Ia+Ib+Ic)/3 (1)

RESULT

The plot of three phases to ground fault current is shown in Figure 2. Where the X-axis denotes current magnitude and the Y-axis represents the time period during which current deviation occurs. The first section depicts the current deviation caused by the existence of zero sequence components. The later section demonstrates how the current is progressively compensating.

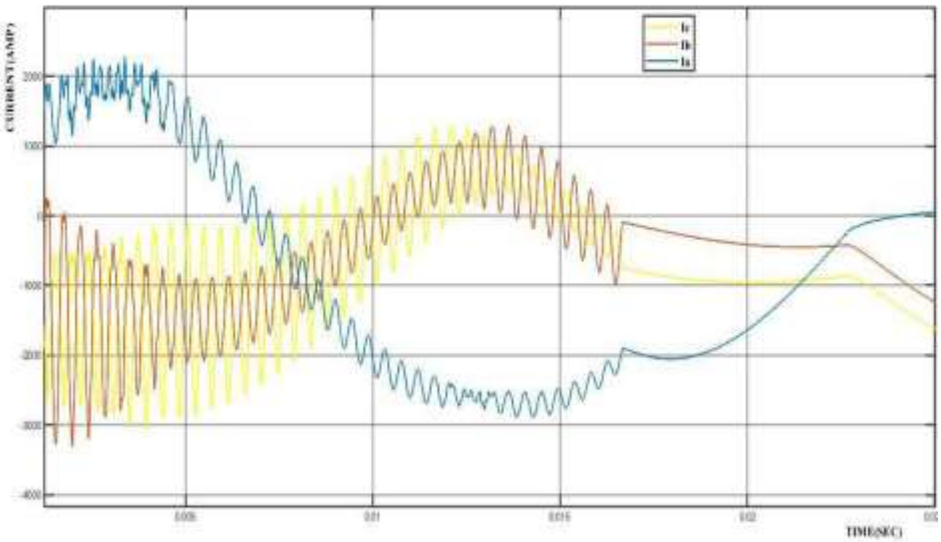

Figure:-2 Deviation of Current due to DC Component

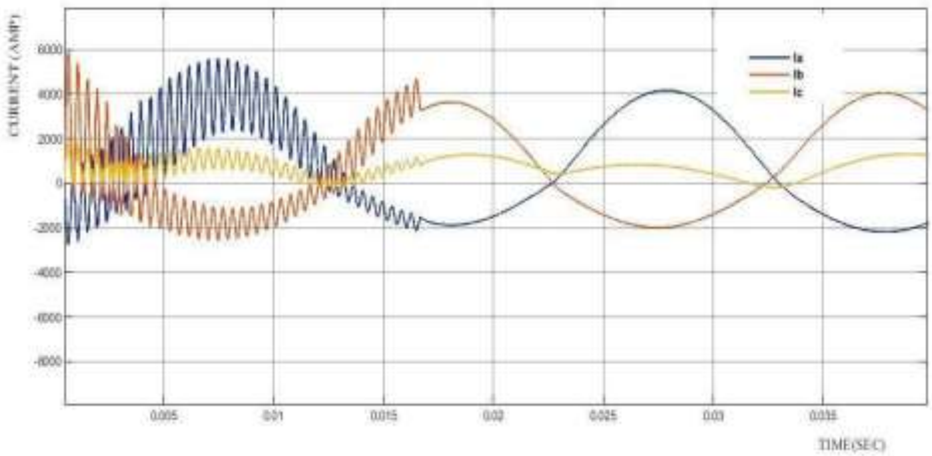

Figure:-3 Modified Current after ZSC Elimination.

Table I: ZSC Value According to Change in Fault Location

Sr. No.	Fault Location (KM)	ZSC (Amp)	
		Maximum	Steady
1.	1	4000	2700
2.	2	3800	2600
3.	3	3500	2550
4.	4	3200	2500

Figure 3 shows that differential current values have been improved to very low values that are close to zero. As a result, the suggested approach was successful in removing ZSC components from differential currents.

The transmission length is raised from 1 kilometre to 2 kilometres, and simulation is performed with this length, as indicated in Table I.

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