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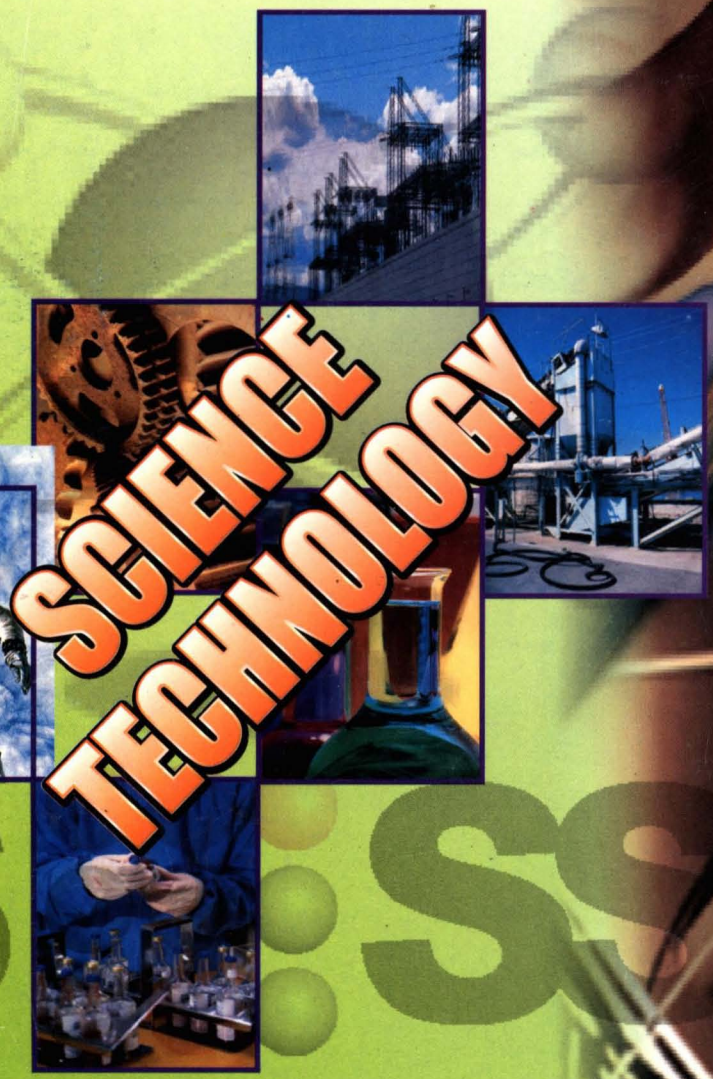

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Effect of Mismatching Currents on Performance Of Differential Relay (87)

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ABSTRACT

Transformers need to be protected not only from internal short circuits, but also from abnormal operating conditions, such as over loading, inrush currents, go-through faults and surges. The simplest but extremely effective form of protection is the electromechanical relay, which closes contacts and hence energizes the circuit-breaker opening mechanisms when currents larger than allowed values pass through. In a power system, the differential relay should operate only in its indicated protection zone, and not for out of its protection zone. This paper will focus on the problem, where the differential relay (87) indiscriminately functions for its out of protection zone. Effect of mismatching currents has been considered.

Keywords: *Transformer Differential Relay 87*

Introduction

The differential protection relay works on the principle that "in a healthy system" the current leaving a circuit is equal to the current entering the circuit (Blackburn 1998). If there is an internal fault, part of the incoming current is diverted into the fault. Hence the value of the outgoing current will not be equal to the incoming current. The differential principle can be applied to a transformer (even though the primary and secondary currents are not equal), by rating the CTs according to the transformation ratio.

Two sets of CTs (of the corrected ratio) are installed on either side of the transformer in order to measure the 'differential' value between incoming and outgoing current. A common problem in differential transformer protection is, the mismatch of relay currents that occurs when standard CT ratios are used. If the primary voltage rating in a system is changed to a new value instead of previous one, because of some different design or whatever circuit changing in that particular system, then primary current rated will be changed as well. Now, primary winding needs a new rating of CT. The new CT gives a different rated condition, and will not be balanced to the secondary winding CT. In this situation, the mismatch will goes up, which is not suitable for differential protection and designing of current transformers (Power System Analysis & Design with Personal Computer Applications 1987).

Protection zone for differential protection for a transformer is the limited zone between transformer primary side CTs and transformer secondary side Cts. If a short circuit fault occurs in the mentioned zone, then the differential relay will operate to protect transformer not to be damaged by the high short circuit current. The problem is shown itself, when differential relay (87) is functioning in out of its protection zone. Manually fault trip on the transformer itself and load side of protection circuit had been already tested by the other researchers.

Experimental

To reach the objective of this paper, and to find out more detail about transformer unit against differential fault, an electrical circuit with connection of CTs in the primary side, and in the secondary side of a 5 kVA transformer, a relay (87), and matching current transformers had been arranged by researcher.

The protection circuit requires a protective function of differential relay system. The circuit for transformer differential protection, consists of a three-phase transformer, six current transformer (CT), three auxiliary transformers (current matching transformers), an automatic tripping switch (circuit breaker), and a device of a digital differential relay (87) which is being used for transformer differential protection.

The auxiliary CTs, which are used for the circuit, can be matched with main CT. They are small and inexpensive devices since their primary and secondary windings are low-voltage low-current circuits (W.D. Stevenson 1982).

Connection Procedures

Connection of power transformer, CTs, resistive-loads, current-balancing-auto-transformers, and relay (87), are shown in Figure 1.

a. CTs on primary side of power transformer are connected in star (Schweitzer Engineering Laboratories 2001).

b. CTs on secondary side of the power transformer are connected in delta (Schweitzer Engineering Laboratories 2001).
c. To be able to send two balance currents to differential relay (87), three current balancing transformers had been used in secondary side of power transformer.
d. Three resistive loads of 110V connected in star or delta whether to get more or less load current.

Transformer Tripping and Disconnection

Two tripping circuit have been provided for this project in order to protect main transformer and other part of the circuit from abnormal condition received by the relay.
They are:
a. A contactor as a main circuit breaker with 15A standing current on its contacts. The magnetic-coil of this contactor operates by 240Vac supply.
b. A low voltage relay of 6Vdc or 9Vdc is to be used as sub-main contactor controller.

Testing Relay with Faults

Differential relay (87) test set up is shown in Figure 1. To set-up the relay (87), indicated output of relay to an input terminal of a personal computer is connected. By supplying a 415Vac three- phase voltage, the circuit can be tested. To obtain the differential relay setting point, in normal condition, current going in to AW1, BW1 and CW1 of the relay should be equal to current going into AW2, BW2 and CW2 of the relay. Now if difference amount of incoming currents to relay (87) appears (abnormal conditions), relay operates and sends a trip signal and opens the protective related switches.

Now if the fault-switch of the circuit is brought into the on position, a spark will be appeared due to the high value of short-circuit current. While relay (87) operates, circuit breaker will trip the transformer. The whole circuit will be disconnected from the main supply voltage.

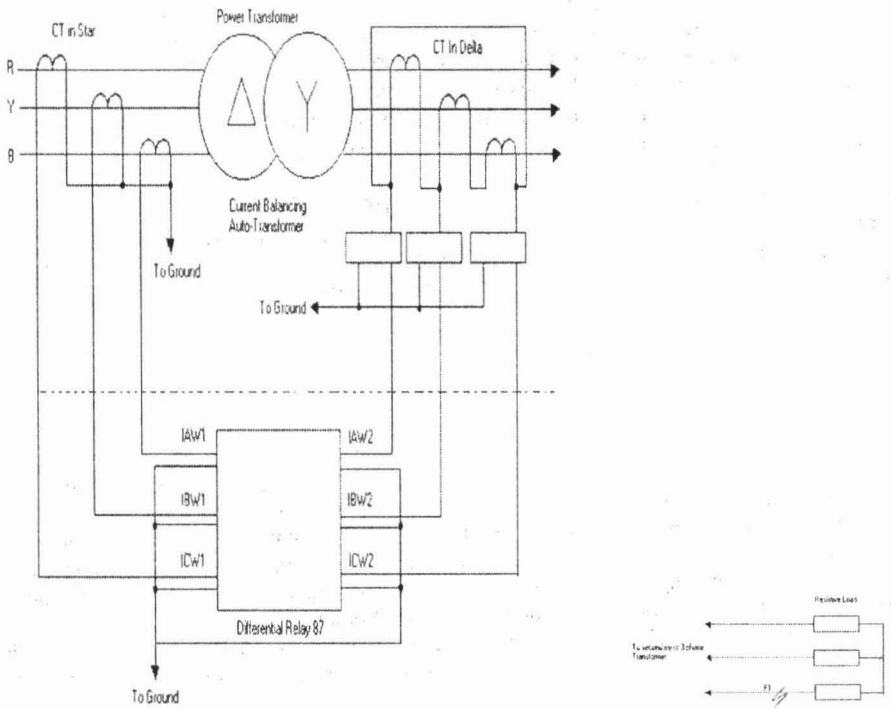

Fig. 1: Schematic (a) CTs and transformer (b) Loads

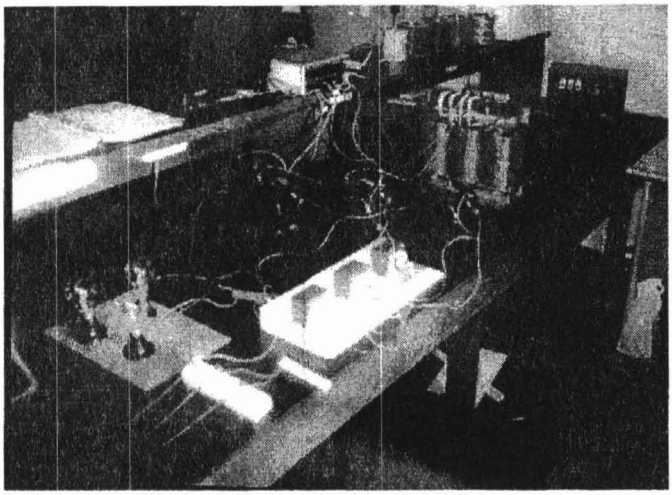

Photo 1: The connection of transformer, loads, current transformers, and current-balancing auto-transformers with PC and relay (87)

Discussion

In this experiment, the relay (87) which is connected to circuit for differential protection purpose, can be tested by bringing different faults at different points in the circuit. Testing of faults in this experiment have shown that, if rating-current of CTs and rating-current of balancing-transformer have not been matched properly with primary/ secondary side of the transformer, the relay (87) will operate wrongly in the out of its protection zone.

Conclusion

The differential relay (87) at its protection zone and out of its protection zone had been tested by experiment explained in this paper. To obtain correct operation of relay, the rating of CTs, and rating of current-balancing devices base on primary/secondary current of transformer should be selected correctly. If currents are different then must be matched. Even a small differs can lead to mal-operation of differential relay.

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