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Protection Agains Loss of Excitation of Synchronous Generator

KEYWORDS: Loss of Excitation, Protection Scheme, Comparison of Protection Scheme, Implementation of Protection Scheme, Operation and Working.

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ABSTRACT *The aim of this paper is to study the impact of Loss of Field protection at generators on the grid stability of the interconnected power system. Loss-Of-Excitation condition of a generator may cause severe damages on both generator and the interconnected systems. This paper analyses the behaviors of LOE protection scheme, such as R-X schemes for a generator and implementation of R-X scheme for loss of Excitation protection.*

INTRODUCTION

Loss Of excitation (LOE) is a very common fault in synchronous machine and can be caused by short circuit of the field winding, unexpected field breaker open or LOE relay mal operation. According to the statistic, the generator failure due to LOE accounts for 69.5% of all generator failures. LOE may cause severe damages to both generator and system. Now, consider that the field excitation is lost while the mechanical input remains intact since the Generator is already synchronized with the grid, it would attempt to remain synchronized by running as an induction generator. As an induction generator, the machine speeds up slightly above the synchronous speed and It draws reactive power from the system, amounting to as much as 2 to 4 times the generator's rated load.[1]

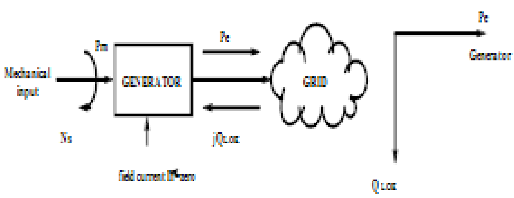

Figure: 1 After Loss of Excitation

LOSS OF EXCITATION PROTECTION SCHEMES:

- **Under Current Relay**

An undercurrent relay across a shunt in the field circuit can detect loss of excitation. The relay normally, remains energized and on loss of excitation, drops off causing tripping as desire.

- **Monitor The Field Current**

The simplest method by which loss of excitation can be detected is to monitor the field current of the generator. If the field current falls below a threshold, a loss of field signal can be raised. A complicating factor in this protection is the slip frequency current induced in the event of loss of excitation and running as an induction generator. This scheme also does not detect rotor shorts that result loss of effective excitation.[3]

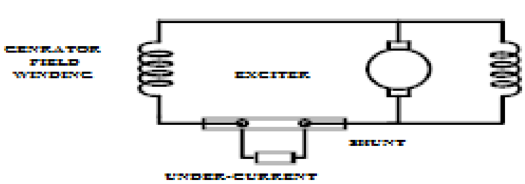

Figure: 2 under current Relay

- **Mho Relay**

The impedance measurement is widely used for LOE protection. The protection scheme applies an offset mho relay, which receive the terminal voltage and current as input signals to calculate the terminal impedance. The distance relay is a kind of relay that measures the circuit impedance compared with the predefined value to determine whether the fault occurs or not. The distance relay will operate, when the measured impedance falls into the relay operation zone.[2]

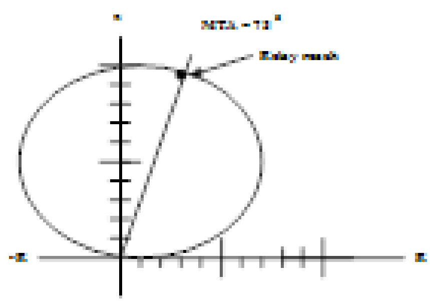

Figure: 3 Mho Relay Characteristics

DIFFERENT SCHEME USED IN PROTECTION OF LOSS OF EXCITATION:

The reliability and stability of existing LOE protection schemes are compared and a preferred scheme is selected.

Table 1: Protection Scheme Comparison

R-X scheme	LOE protection scheme which is based on generator terminal Impedance measurement in R-X plane. This protection scheme applies two offset mho impedance circles by using the generator terminal side voltages and stator currents as input signals.
G-B scheme	LOE protection scheme which is based on generator terminal Admittance measurement in G-B plane.
P-Q Scheme	LOE protection scheme which is based on generator active and reactive power output measurement in P-Q plane.
U-I scheme	LOE protection scheme which is based on the measurement of phase angle difference between phase voltage and current. U-I scheme implements a directional over current relay to detect LOE faults by comparing the phase angle difference between voltage and current.

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We are comparing the behavior of the above mentioned protection schemes during LOE conditions and external faults. Each scheme is evaluated under the same operating conditions and one with the best performance is selected. The R-X with directional element scheme responds faster for LOE faults than other schemes. However, R-X, G-B and P-Q schemes need longer time to detect the LOE faults. Besides, G-B, P-Q and U-I schemes may not respond to the LOE faults under synchronous condenser operating mode.[6]

PROPOSED IMPLEMENTATION OF PROTECTION SCHEME:

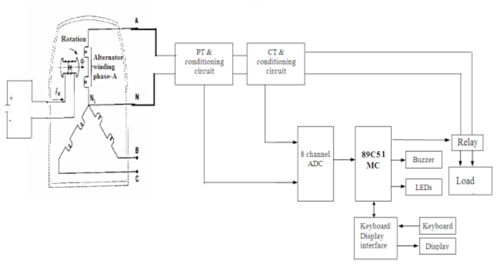

Figure: 4 Proposed Protection Scheme Block Diagram

In this block diagram we are using mainly two types of sensor that is current sensor and voltage sensor. Now first of all power supply is given to that two sensor and from that we can sense voltage and current. Outputs of that sensor are given to the ADC, and from the ADC it is given to the microcontroller ckt. Then output of the microcontroller circuit is given the LCD and Relay.[8]

Here as shown in figure of main diagram of the implemented circuit in proteus.

Now there are mainly two conditions.

- Before loss of excitation
- After loss of excitation

➢ **Before loss of excitation :-**

In normal condition V & I both in range so the ratio V / I are in the limit of pre-defined value, so impedance Z=V / I is in pre-defined limit. So it gives low signal to the microcontroller. in the normal condition LED is ON and Relay is OFF.

➢ **After loss of excitation :-**

In faulty condition limit of V is Violated or limit of I is Violated so the ratio limit of impedance Z= V / I is violated from the pre-defined value. So it gives high signal to the microcontroller And it give the tripping signal to the Relay in the Faulty condition. So LED is OFF and Relay is ON. We will protect the generator and system from over and under excitation. In below fig.6 current value is higher than predefined value so relay is operated & vice-versa.

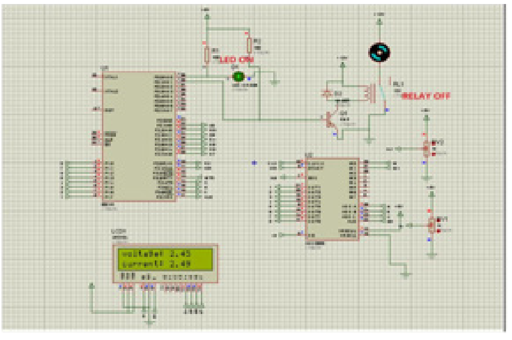

Figure: 5 Before loss of excitation

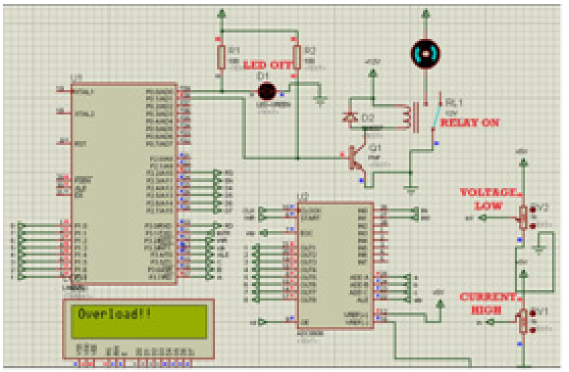

Figure: 6 After loss of excitation

HARDWARE IMPLEMENTATION:

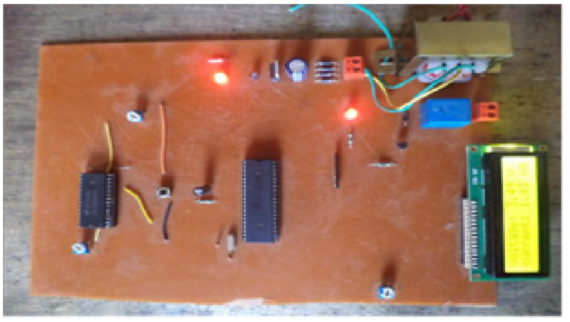

Figure: 7 Hardware Implementation

Here in this protection scheme we are using microcontroller kit with ADC 0808 and LCD. Also we are using relay for the tripping. Here are given the 5v dc supply to the controller. Also PNP transistor is used for the Connection of the Relay.

RESULT COMPARISON WITH EXISTING PROTECTON SCHEME

Table 2: Result Comparison with Existing Protection Scheme

After Loss of Excitation		Pro-posed scheme	RX	GB	PQ	UI	Out of Step
80% load	Alarm signal	2 s	2.9s	4.76s	4.03s	3.97s	7.13 s
	Trip signal	3.5 s	5.42s	6.72s	4.73s	5.47s	

In table 2 shows comparative result with existing protection scheme. As given in table proposed protection scheme is very fast compare to Existing protection scheme.

FLOWCHART:

As given in the flowchart first of all we select the voltage channel from that we can get the voltage, and then stored in the EPROM. then we select the current channel and get the current from that ,stored in EPROM. Then calculate the impedance Z , by taking the ratio of V/I Z=V/I If the data limit is in the pre-defined value at that time loop is continue repeated , if the limit of Z is crossed at that time it give the alarm signal to the ckt.

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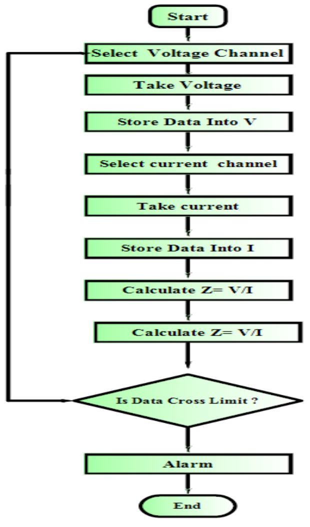

Figure: 8 Flow Chart

CONCLUSION:

This thesis analyzes the common existing protection schemes for LOE faults and compares the reliability and stability among these schemes. A proposed loss of excitation protection scheme based on the variation of the impedance has been presented Extensive tests show that the proposed method has various distinctive features that are advantageous over existing schemes. The first is that the proposed scheme is able to detect LOE during various kinds of loading and power swings and it was found that the proposed protection can still perform satisfactorily under and over excitation.

Based on the comparison with the latest paper, the proposed method is faster than the conventional protection scheme. In addition such as a directional element (directional control), an under voltage element (voltage control) provide security against mal-operation. It gives high level of flexibility and high speed protection. Due to self checking features, it increases reliability and the propose protection scheme will detect a loss of field from full load to almost no load. Thus, it can protect the generator from the overload condition as well as under voltage condition.

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