Volume 6, Issue 1, January 2019 ISSN: 2348-8565 (Online)
International Journal of Modern Engineering and Research Technology
Website: http://www.ijmert.org Email: editor.ijmert@gmail.com

Three Phase Induction Motor Protection Using Non-Directional Over Current Relay

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ABSTRACT

Organizations which are responsible for the electric power generation, transmission and distribution of the generated energy, has to deliver energy for their consumers. Companies should provide energy constantly with high quality and the cheapest way possible. Power plants are complex structure. Quality and reliability of the provided energy depends on fast and selective protection of it. One of the basic problems of electrical engineering is to protect these kind of facilities and deliver the generated energy efficiently. Protection relay plays a crucial role in delivering part of this process. Protection relays have the highest priority for protection of power systems and they are many and varied. In this study, an electromechanical overcurrent protection relay's operating characteristic curves were obtained, then experimentally investigated and presented. Experiment took place in Marmara University, Laboratory for Electrical Installations The experimental data were estimated using the Artificial Neural Network (ANN) method and the characteristic curves of the run time. Moreover, overcurrent relay in the validation study was carried out with the data obtained from the mathematical model.

Keywords:— *Electro mechanical over current Protection rela, Artificial Neural Network.*

I. INTRODUCTION

1.1 Properties of an Efficient Protection System

Switchgears like generator, transformer, line, cutter, splitter etc. can be damaged during an insulation error or short circuit in electrical delivery system. Therefore, errors need to be cleaned as soon as possible to limit the damage and eliminate the negative effects on the stability of the system. In accordance of a short circuit or insulation error, relays protect the power system immediately or with an acceptable delay. If the changes in terminals happen instantly whenever relay is stimulated by the unit which is related with it then the relay is called instant time relay. Energy systems frequently observed transient faults and short-term overloads. Therefore, for the protection of power systems, system protection relays which can delay the time are preferred [1], [2]. These protection relays are called delayed time relays. For these relays, delay time can be constant or inverse. Over current inverse time relays are manufactured and grouped in 3 main types: Standard inverse time (SIT) relays, very inverse time (VIT) relays and ultra inverse time (UIT) relays. In these kind of relays work time and work unit are negatively correlated.

Run-time is determined by stimulation magnitude for relay characteristics or operating characteristic curves. Relay characteristics (operating characteristics) curves are logarithmic scaled and plotted as appropriate relays set value, the value is determined by the size of the run-time warning. Different release times are obtained by selecting different curves for same excitation size. In particular this is to ensure the coordination of relay networks fed by successive curves (Time Dial Setting) will benefit [1].

1.1.1 Reliability

Reliability is the ability of interfering any kind of malfunctions with a secure and effective way. The reliability of a device or equipment defines its quality during its operational life. Acquiring the reliability as a numerical value allows obtaining information about the device or equipment's rate of meeting the expectation during its operational time. The reliability of each device in the system defines the total reliability of security level. Also, parallel protection members are used in order to raise the reliability of the system. In order to raise the reliability over current, short circuit, earth leakage relays and subjective protection relays are used. Thus, in a malfunction moment, the magnitude of excitation is felt by more than one relays and the relay which has the shortest exposure time gives exposure and annunciation command and takes the transformer out of service.

1.1.2 Selectivity

Selectivity is the process that separates only the malfunctioned part from the system in order to keep the continuity of energy in the system, which are separated in protection zones while security systems are planned. These are; link protection zone, bar protection zone, transformer protection zone, feeder protection zone etc. In any malfunction that occurs in this protection zone, the relays that protect the zone activate. If those relays do not get activated for some reason, then backup protection relays continue to protect the system. Therefore, the protection selectivity is the process that makes the protection setups to keep the other zones continuing the operation by deactivating the malfunctioned operator device after identifying the exact type and spot of the malfunction.

1.1.3 Speed

The malfunction time and equipment damage can be minimized by speed of the reaction time of the protection relays. The quicker the malfunction in an operating device is located and the device is deactivated, the cheaper will be the costs. Additional to that fact, the quick restoration of malfunction also provides the dynamic stability of the grid. Short circuit voltage and the short circuit resistance duration of transformers are related. According to VDE standards, the short circuit resistance duration of power transformers are given in Table 1, depending on rates of percentage of Uk. A power transformative which is Uk percentage equals to 5% and it can resist the short circuit for 2.8 seconds. If it does not taken out of service in the end of the duration represented in the Table 1, high temperature reaches to the ignition temperature of transformer oil and causes it to burn. Thus, in case of a malfunction the transformer and other equipment devices should be deactivated as soon as possible in case of a short circuit or short term over load.

II. Types Of Protection

a. Unit Type Protection

Unit type schemes protect a specific area of the system, i.e., a transformer, transmission line, generator or bus bar.

The unit protection schemes is based on Kirchhoff's Current La – the sum of the currents entering an area of the system must be zero.

Any deviation from this must indicate an abnormal current path. In these schemes, the effects of any disturbance or operating condition outside the area of interest are totally ignored and the protection must be designed to be stable above the maximum possible fault current that could flow through the protected area.

b. Non unit type protection

The non-unit schemes, while also intended to protect specific areas, have no fixed boundaries. As well as protecting their own designated areas, the protective zones can overlap into other areas. While this can be very beneficial for backup purposes, there can be a tendency for too great an area to be isolated if a fault is detected by different non unit schemes.

The most simple of these schemes measures current and incorporates an inverse time characteristic into the protection operation to allow protection nearer to the fault to operate first.

C. Overcurrent Relay Purpose and Ratings

A relay that operates or picks up when it's current exceeds a predetermined value (*setting value*) is called Overcurrent Relay.

Overcurrent protection protects electrical power systems against excessive currents which are caused by short circuits, ground fault, etc. Overcurrent relays can be used to protect practically any power system elements, i.e. transmission lines, transformers, generators, or motors.

For feeder protection, there would be more than one overcurrent relay to protect different sections of the feeder. These overcurrent relays need to coordinate with each other such that the relay nearest fault operates first.

Use time, current and a combination of both time and current are three ways to discriminate adjacent overcurrent relays.

d. Over Current Relay gives protection against:

Overcurrent includes short-circuit protection, and short circuits can be:

- Phase faults
- Earth faults
- Winding faults

Short-circuit currents are generally several times (5 to 20) full load current. Hence fast fault clearance is always desirable on short circuits.

e. Primary requirement of Overcurrent protection

The protection should not operate for starting currents, permissible overcurrent, current surges. To achieve this, the time delay is provided (in case of inverse relays).

The protection should be co-ordinate with neigh boring overcurrent protection.

Overcurrent relay is a basic element of overcurrent protection.

III. Electromechanical Relays And Their Use In Protection Systems

Electromechanical relays have been reliably in use for protection of the power systems since the initiation of use of electricity in 1878. In recent decades, developments in semiconductor technology has enabled relays to work faster and more reliable [3]. Electromechanical relays work on a principle of adaptive current or voltage. Depending upon the type and kind of protection in need, relays which correlates with the magnitude of current-current, current-voltage or voltage-voltage are in use [4]. By using these magnitudes together, watt metric relays, directional relays, ratio relays and relays conduct comparison are obtained. There are two drawbacks of electromechanical relays. One of them is their system of operation with a certain amount of friction and the other is in some cases they need mechanical adjustment of their current reaction. During the time due to wear and tear their structural properties deteriorate which in turn leads to deviation from intended use via calibration degradation. In addition to this, another drawback of these relays come up : Electro magnetically relays cannot be remotely observed and alerted about their failures.

IV. Induction Type Over-Current

Protective Relays

Operating principles of induction relays are similar to the induction motors operating principles. Rotation of the rotor is obtained through a moving transmitter (a disc) and magnetic fields placed on various parts of this particular disc. As magnetic fields and stators are fixed, the magnitude of induction applied to these points must be variable. The metal disk is inserted in between the magnetic fields with an insignificant friction and rotates easily. Induction over-current relays are manufactured in two main types which are directional and non-directional. If the relay was designed to operate in single induction magnitude, regardless of the polarity of the current, it shall operate in single direction. In some cases, relays are required to be sensitive towards the currents beyond where they are fixed only. In such cases, relays are manufactured to operate with both current and voltage induction magnitudes and reverse rotation is mechanically inhibited. Induction overcurrent relays‟ switching on time has inverse relation with the current. They generally are manufactured as standard inverse timers. Through percentage switch placed on these relays they can be adjusted to any value between 0 and 100 to coordinate the over-current. The actual operation in essence is nothing more than bringing moving contact and fixed contact closer and apart. Thus, different switching times are obtained at the same relay characteristic and current. Time lag delays for the over current relays can be calculated by using the manufacturers manuals provided for the particular relay. Overcurrent relay manufacturers provide characteristic time-current chart for their product based on the magnitude of the current in terms of percentage value for various currents. Time-current characteristics and standard inverse time.

Figure 1: Over Current Relay

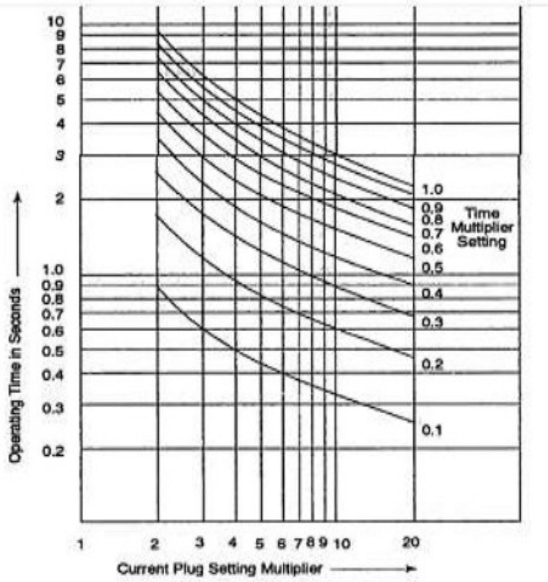

Figure 2 :Time-to-current levels of characteristic of standard, over and ultra over inverse time over current relay

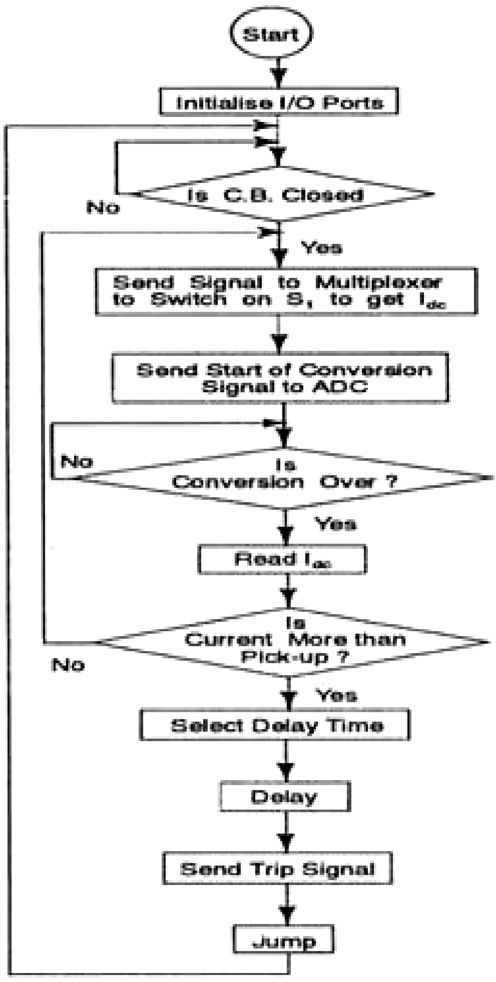

Figure 3. Flow Chart for Over Current Relay

V. CONCLUSION

Overcurrent relaying is very well suited to Three Phase Induction motor's protection for the following reasons: It is basically simple and inexpensive. Very often the relays do not need to be directional and hence no PT supply is required. It is possible to use a set of two O/C relays for protection against inter-phase faults and a separate Overcurrent relay for ground faults. And also this project safeguard the induction motors during hazardous conditions.

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