Impact Factor (SJIF): 3.632

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

(Special Issue for ITECE 2016)

REVOLUTION IN RELAYS AT A GLANCE

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Abstract --- Protective relays works as sensing and control devices to make system more healthy and protective. Basically relay sense the abnormalities of the system and gets operated when fault occurs. This paper deals with History and Revolution in Protective Relays. In this paper we have included the basic concept of relays.

Keywords --- History of Relay, Function of different relays, Limitations, Improvement in relays.

I. INTRODUCTION

A Power System contain various electrical components like Generator, Transformers, Transmission lines, Isolators, Circuit breakers, Bus bars, Cables, Relays, Instrument transformers, Distribution feeders, and various types of loads. Faults may occur in any part of power system, it may be Single Line to Ground, Double Line to Ground, Line to Line, three phase short circuit etc. Its level also depends on the fault impedance which depends on the location of fault referred from the source side.

The protection system operates and isolates the faulty portion. The operation of the protection system should be quick and selective i.e. it should isolate only the faulty portion in the shortest time causing minimum disturbance to the power system. Also, if main protection system fails to operate, there should be a backup protection for which proper relay co-ordination is required. Failure of a protective relay can result in equipment damage.

WHAT IS RELAY: relay is automatic device which senses an abnormal condition of electrical circuit and connects its contacts, which closes the circuit, Hence circuit breaker gets tripped for disconnecting the faulty portion of the electrical circuit from rest of the healthy circuit.

FUNCTION OF PROTECTIVE RELAYS:

1. To sound an alarm or to trip the circuit breaker so as to disconnect Faulty Section.
2. To disconnect the abnormally operating part so as to prevent faults. For e.g. Overload protection of a machine protects the machine as well as prevents Insulation failure.
3. To isolate or disconnect faulty circuits or equipment quickly from the system so the system can continue to function and to minimize the damage to the faulty part. For example – If machine is disconnected immediately after a winding fault, only a few coils may need to replace, but if the fault is sustained, the entire winding may get damaged.
4. To localize the fault by disconnecting the faulted portion from healthy part, causing least disturbance to the healthy system.
5. To disconnect the faulty part very quickly to improve the system stability, service continuity and system performance.

WORKING OF PROTECTIVE RELAYS

Protective relaying senses the abnormal condition in a particular portion in power system and sounds an alarm or isolates that part from healthy portion of system. Protective relaying system is a combined work of CT, PT, protective relays, time delay relays, trip circuits, circuit breakers etc.

Protective relaying has an important role in minimizing the faults and also in minimizing the damage during the faults.

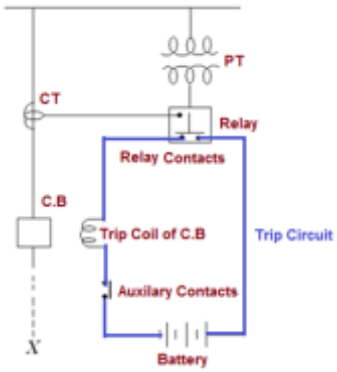

Figure1. Working principle of relay

Figure shows basic connections and operation of circuit breaker control for the opening operation. The protected circuit is shown by dashed line. When a faulty condition occurs in the protected circuit the relay connected to CT and PT actuates and closes its contacts.

Current flows from battery in the tripped circuit. As the tripped coil of circuit breaker is energized, the circuit breaker operating mechanism is actuated and it operates for the opening operation. Thus the fault is sensed and the faulty part is isolated.

II. HISTORY OF PROTECTIVE RELAY

The evolution of protective relays starts with the electromechanical relays, over the past decade it upgraded from electromechanical to solid state technologies to predominate use of microprocessors and microcontrollers.

The timeline of the development of protective relays is shown below

Table1. History of protective relays

1900 to 1963	**1963 to 1972**	**1972 to 1980**	**1980 to 1990**
ELECTROMECHANICAL RELAY	STATIC RELAY	DIGITAL RELAY	NUMERICAL RELAY
1925:Single Disc Type Relay (Single Input)	1963:Static Relay (All Purpose)	1980:Digital Type Relay (All Purpose)	1990:Numerical Type Relay (All Purpose)
1961:Single Cup Type Relay (Impedance Relay)	1972:Static Relay with self checking (All Purpose)		

III. ELECTROMECHANICAL RELAY

History of Electromechanical Relay: This is the first generation oldest relaying system and they have been used for many years. They have earned a well-deserved reputation for accuracy, dependability, and reliability. There are two basic types of operating mechanisms: 1) the electromagnetic-attraction relay &2) electromagnetic-induction relay.

Measuring Principles: This relay converts the voltages and currents to magnetic and electric forces and torques that press against spring tensions in the relay. The tension of the spring and taps on the electromagnetic coils in the relay are the main processes by which a user sets in a relay.

Limitations of Electromagnetic relays:

1. Low speed of operation.
2. Component failure may lead to relay failure.
3. Bulky equipment, because there are internal mechanical components with physical dimension restraints, the package size of an electromechanical Relay can limit the size of a PCB design. Excessive power consumption.
4. No fault data available except phase indication.
5. Electromechanical Relay must make mechanical contacts in order to switch a load. At the point of these contacts, oxidation breakdown occurs over extended life cycling (typically 106 operations), and the relay will need to be replaced.
6. When an electromechanical Relay is activated, bounce occurs at the contact site which creates a window of time where the load circuit is flickering between open and closed, a condition which may need to be considered in load design.
7. Isolation voltage is another area where Electromechanical Relays are limited.

IV. SOLID STATE RELAY (STSTIC RELAY)

History of Static Relay: The static relay are next generation relays .The Static relays was first introduced in 1960's. The term 'static' implies that the relay has no moving mechanical parts in it. Compared to the Electromechanical Relay, the Solid Static relay has longer life-span, decreased noise when operates and faster respond speed. However, it is not as robust as the Electromechanical Relay.

Static relays were manufactured as semi conductor devices which incorporate transistors, ICs, capacitors, small micro processors etc.
The static relays have been designed to replace almost all the functions of electromechanical relays.

Measuring principles: The working principle of the Solid Static relays is similar to that of the Electromechanical Relay which means the Solid Static relays can perform tasks that the Electromechanical Relay can perform.

The Solid Static relays use analogue electronic devices instead of magnetic coils and mechanical components to create the relay characteristics. The measurement is carried out by static circuits consisting of comparators, level detectors, filter etc. The relaying quantity such as voltage/current is rectified and measured. When the quantity under measurement attains certain well-defined value, the output device is triggered and thereby the circuit breaker trip circuit is energized.

Limitations of static relays:

1. Auxiliary voltage is required for Relay Operation.
2. Static relays are sensitive to voltage transients which are caused by operation of breaker and isolator in the primary circuit of CTs and PTs.
3. Serious over voltage is also caused by breaking of control circuit, relay contacts etc., which spikes of small duration can damage the semiconductor components and also cause mal operation of relays.
4. Temperature dependence of static relays as the characteristics of semiconductor devices are affected by ambient temperature.
5. Highly sophisticated isolation and filter circuits are required to be built into the relay design to take care of electromagnetic interference and transient switching disturbances in the power system.

6. Highly reliable power supply circuits are required.
7. Effect of environmental conditions like humidity, high ambient temperature, dust accumulation on PCB are leading to tracking.
8. The component failure may occur.
9. No availability of fault data.
10. Characteristic varies with passage of time.
11. To overcome these disadvantages of ststic relay, Digital Relays were invented.

V. DIGITAL RELAY

History of Digital Relay: Around 1980s the digital relay entered in the market. Compared to the Solid State Relay, the digital relay takes the advantages of the developed microprocessors and microcontrollers. Instead of using analog signals, the digital relay converts all measured analog quantities into digital signals.

Digital protection relays is a revolution step in changing Relay technology. In Digital Relay Microprocessors and micro controllers are used in place of analogue circuits used in static relays to implement relay functions. Digital protection relays introduced in 1980. However, such technology will be completely superseded within the next five years by numerical relays.

In distribution applications, the replacement by the digital relay proceeded a bit more slowly. While the great majority of feeder relays in new applications today are digital, the solid state relay still sees some use where simplicity of the application allows for simpler relays, and which allows one to avoid the complexity of digital relays

Measuring principles: Digital relays introduce Analogue to Digital Convertor of all measured analogue quantities and use a microprocessor to implement the protection algorithm. The microprocessor may use some kind of counting technique, or use the Discrete Fourier Transform (DFT) to implement the algorithm.

The Microprocessors which are used in Digital Relay have limited processing capacity and memory compared to that provided in numerical relays.

Limitations of Digital Relay:

1. It has short lifetime due to the continuous development of new technologies.
2. The devices used in digital relay become obsolete rapidly.
3. Susceptibility to power system transients.
4. Due to complexity of digital system, they require specially trained staff for Operation.
5. Proper maintenance of the settings and monitoring data.

VI. NUMERICAL RELAY

History of Relay: The first protection devices based on microprocessors were employed in 1985. The widespread acceptance of numerical technology and the experiences of the user helped in developing the second generation numerical relays in 1990.

Conventional electromechanical and static relays are hard wired relays. Their wiring is fixed, only their setting can be manually changed. Numeric relays are programmable relays. The characteristics and behavior of the relay can be programmed.

First generation numerical relays were mainly designed to meet the static relay protection characteristic, whereas modern numeric protection devices are capable of providing complete protection with added functions. Numerical protection devices offer several advantages in terms of protection, reliability, and trouble shooting and fault information.

The distinction between digital and numerical relay rests on points of fine technical detail, and is rarely found in areas other than Protection. They can be viewed as natural developments of digital relays as a result of advances in technology. Typically, they use a specialized digital signal processor (DSP) as the computational hardware, together with the associated software tools.

Limitations of Numerical Relay:

1. Numerical Relay offers more functionality, and greater precision. Unfortunately, it does not necessarily translate into better protection.
2. Numerical Relay can make faster decisions. But, in the real world, faster protection itself is of no value because circuit breakers are still required to interrupt at the direction of the protective equipment, and the ability to make circuit breakers interrupt faster is very limited.
3. Numerical Relay protection often relies on non-proprietary software, exposing the system to potential risk of hacking.
4. There are common failure modes that can affect multiple elements of protection. For example, failure of a power supply or an input signal processor may disable an entire protective device that provides many different protection functions.
5. A multifunction numeric relay can provide 10 – 11 single function Solid State or Electromechanical relays at least 5 to 6 times the cost. Additionally Numeric relays have Communications capabilities, sequence-of-events recording, fault reporting, rate-of-change frequency, and metering functions, all in an integrated system.

CONCLUSION: From this review paper we can easily understood the function of different types of protective relays. We can easily understood the requirement of particular relay in power system protection according to its operation, capacity.

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