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Different Reasons for Mal Operation of Numeric Relay for 220/400kV Line

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Abstract:
Un-interrupt and reliable power supply is very important issue in Electrical power system .Continuous electric supply in not only need for the large industries but it effects all sphere of life medical facilities ,water supply, education, communication system etc. There is direct connection between economic growth of nation and power supply. Fault in any of three sectors of power system results in power losses. To ensure reliable various protection schemes are used at generation, transmission and distribution etc. In-spite of modern and sophisticated protection scheme several times power failures are observed .Protection failure are one the main reason that has been witnessed as cause of the power failure. In protection scheme relays are the main components along with other protecting devices. Today numeric relays are most popular device used for the protection of the power system. Still several cases are seen where power system partially or totally collapse. This research paper aims at providing insight to the various reasons which leads to the mal operation of Numeric relay.

Keywords: *Numeric relay, mal –operation, false transients tripping of circuit breaker*

1. Introduction
On a transmission system the protective relaying system is incorporated to detect the abnormal signals indicating faults and isolate the faulted part from the rest of the system with minimal disturbance and equipment damage to ensure regular, uninterrupted power supply. [i] Transmission lines are among the power system components with the highest fault incidence rate, since they are exposed to the environment. Line faults due to lightning, storms, vegetation fall, fog and salt spray on dirty insulators are beyond the control of man. The balanced faults in a transmission line are three phase shunt and three phases to ground circuits. Single line-to-ground, line-to-line and double line-to-ground faults are unbalanced in nature. [iv] The other faults occurring in power system are unbalanced in nature mainly contributed by various transient occurring in power system due transformer, alternator, frequent load switching. Due to un predicted nature of fault several times mal operation of relay takes places.

2. Necessity for Protection of System
Protection schemes are used for reliable and un interrupt operation of any system (here power system) Electrical power system consist of three main components namely generation system, transmission system and distribution system. Transmission system and distribution system are more prone to several faults because they are exposed to the open atmosphere as compared to the generation system, The failure in any of the three system leads to the loss of power and hence the revenue[ii]., The protection scheme are used for those equipment , device , machine or system where the cost of protection scheme is negligible as compared to the losses to incurred by the company organization .Differential protection scheme are suitable for motor and generator protection at generating station where as wide range of protection scheme at switching yard are used of transmission lines and distribution lines[iv,v], These protection schemes are implemented in power system with the help of relay and circuit breakers.

3. Relays
Relay are basic sensing device used in power to sense the inputs (mostly voltages and currents) from the system/apparatus and issues a trip decision to the circuit breakers, if a fault within the relay's jurisdiction is detected. Till date there are three generation of relay are in use namely Electromechanical Relays, Solid State Relays and Numerical Relays [iii]. The conceptual diagram of relay is shown in figure 1

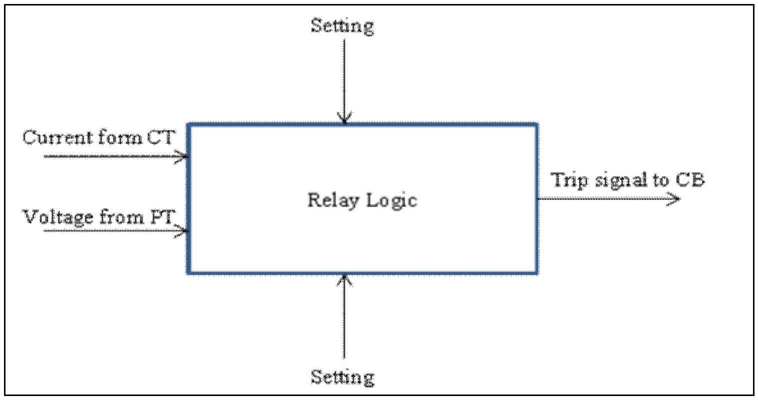

Figure 1: The conceptual diagram of relay

4. Numeric Relay

Since their introduction on 1920, Classic distance relays based on electro-mechanical and then on static technology are still in wide use. However due to the advancement in digital techniques, microprocessor–based relays were introduced. It is quite common to use term digital relay instead of numerical relay as the distinction between both rests on fine technical details [ix,xi]. Others see numerical relays as natural developments of digital relays as a result of advances in technology. However, in US the term (digital distance protection) has always been used in the meaning of (numerical distance protection) [vi]. A general view of the typical digital relay is shown in figure 2.

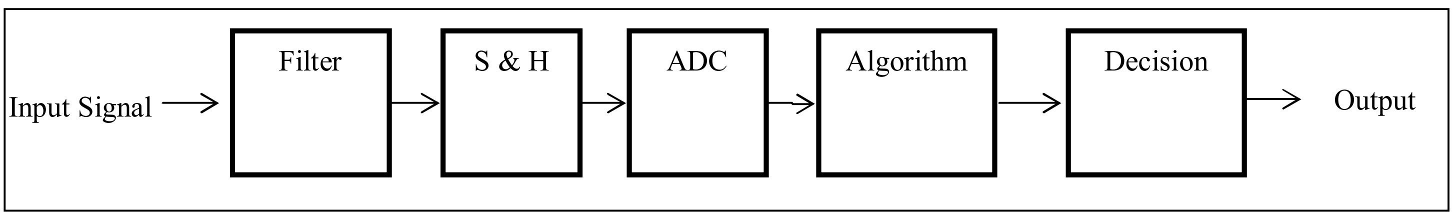

Figure 2: Schematic diagram of Numeric relay

The generalized numerical relay concept is directly derived from open system relaying (different relay functions can be obtained from the same hardware just by modifying microprocessor programming) [xii]. The following hardware modules and functions constitute the generalized numerical relay. In electromechanical relays, the constructional details like magnetic path, air gap etc., are used to design various operating characteristics. Since, solid state relays mainly use analog circuit; they permit more innovation than corresponding electromechanical relays which are no doubt robust [vii]. However, solid state relays can not have the kind of flexibility that computer aided relaying can have. For example, providing magnitude scaling and phase shift to a voltage signal to generate line to line voltage from phase to neutral voltage is much simpler with computer aided relaying because it can be handled by the program [viii]m. A computer relay can be programmed. Further, due to the programming feature, it is possible to have generic hardware for multiple relays, which reduces the cost of inventory .Numerical relaying along with developments in fiber optic communication have pioneered development of automated substations. Once, the analog signals from CTs and VTs are digitized, they can be converted to optical signals and transmitted on substation LAN using fiber optic network [viii]. With high level of EMI immunity offered by fiber optic cable, it has become the transmission medium by choice in substation environment. Numerical relays can be nicely interfaced with a substation LAN. Numerical relays provide maximum flexibility in defining relaying logic.

4.1. Advantages of Numeric Relay

- A computer relay can be programmed.
- Further, due to the programming feature, it is possible to have generic hardware for multiple relays, which reduces the cost of inventory.
- Numerical relaying along with developments in fiber optic communication have pioneered development of automated substations.

4.2. Magnitude and Phase of Current and Voltage Signal during Faults

The voltage and current signals in resistance-inductance behavior of power network are as usual sinusoid with exponentially decaying offsets. The offsets can severely affect the currents but seldom affect the voltage. Figure 3, shows the shape of the fault current at the terminal of a synchronous machine [x]

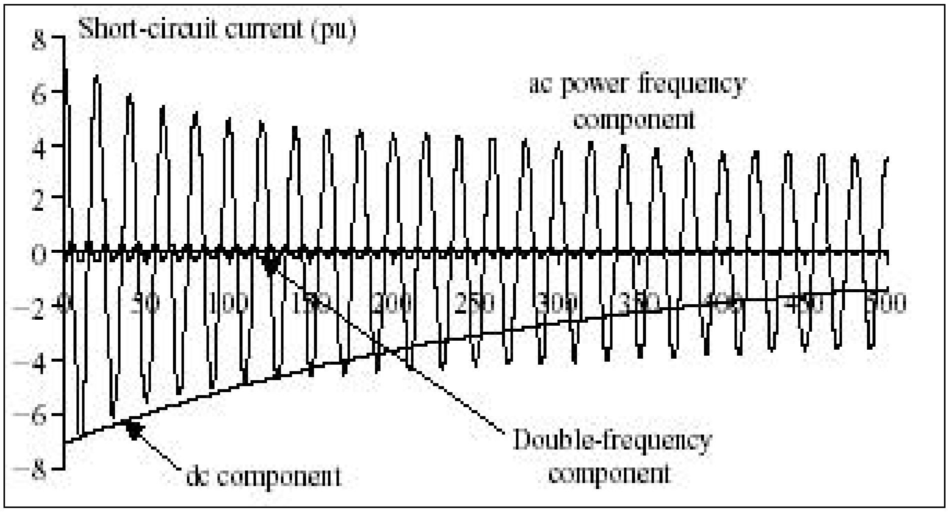

Figure 3: Three-phase short-circuit fault at a synchronous machine terminals

Reasons for transients in power system: Non-linear loads, power transformers and instrument transformers can produce harmonics.[iv.vi] .In addition to that, capacitive series compensation introduces subsystem frequency transients. This transient depends on the percentage of capacitive compensation. Attention has to be given to filters, no matter how they are built; they should have the following characteristics:-Band pass response, about the system frequency, because all other components are of no interest. Dc rejection to guarantee decaying- exponential are filtered out .Harmonic attenuation or rejection to limit effects of nonlinear loads. Reasonable bandwidth for fast response.

5. Methodology

Different model of Numeric relay by different manufacturer has been studied theoretically and for the physical verification of the same relay the real time data was collected from the different organization where such relays are in use [xii]. Three switching yard (sub-stations) were visited on regular basic for data collection. The three switching yard visited are connected to each other by the means of 200/ 400kV single / double circuit lines.

Collecting data from an organization was not enough to come to any conclusion regarding the performance behavior of Numeric. The discussion with engineer`s (both commissioning and operating) was an important basis of the conclusion made in this paper. Some of the data collected under different fault conditions are summarized in table -1

The analysis is made on the basis of observation made at both 200 kV and 400 kV switch yard. The power is transmitted using double circuit220/ 400 kV line. The relative distance between the three switch yards from where the data has been collected is shown in figure 4.

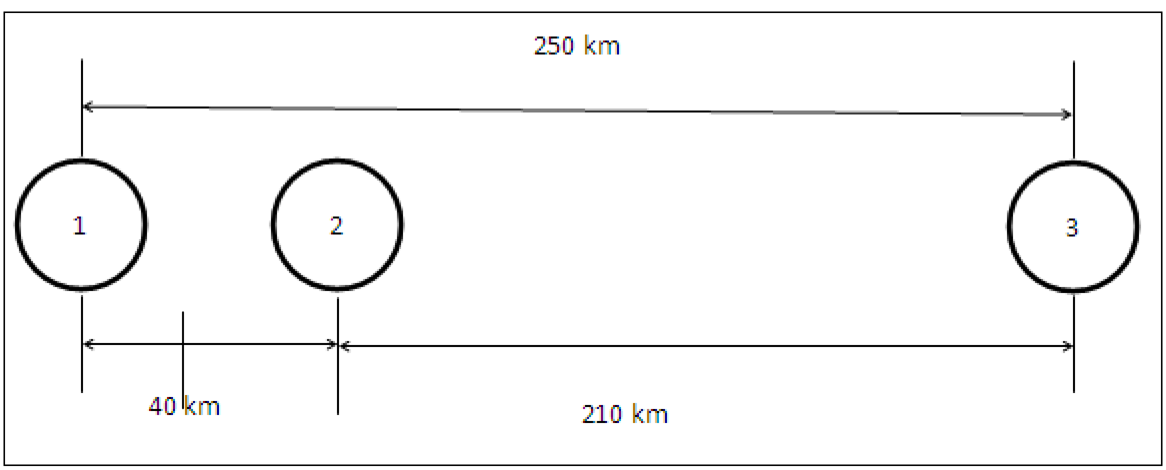

Figure 4: Location of three switching yard

6. Result

S. N.	Beginning of fault	Date	Fault time	Charging Time	220/400 kV S/s	Indication by relay	Type of fault	Remark
1	Switching Yard 2	24.08.2012	02:05 Hrs	02:45 hrs	400kV	No indication	400KV S/c-3, Circuit-2	direct trip command received (CH-2) from Raipur end
2	Switching Yard 1	30.10.2012	12.23.Hrs	12.55 hrs	220 KV	Busbar Protection operated.	Phase B	The fault propagated to 4 other feeders connected to the system. Tripping was also observed in S/s 2.Total load loss 1200 MW
3	Switching Yard 3	13.04.2013	19:48Hrs	21:02 Hrs	400kV	Distance Protection operated	A-N fault Occurred	Auto Reclosed Executed but again fault occurred in same phase A
4	Switching Yard 3	09.07.2013	11:59 Hrs	12:21 Hrs	400kV	Distance protection relay operated	Phase -R	A/R executed but due to persisting the fault 3-pole trip occurred.
5	Switching Yard 3	06.09.2013	02:06Hrs	-	400 kV	Distance protection relay operated	Phase-A-Phase	Undesired tripping signal receive from S/s 2

Table 1: Records of Various fault at three switching yard and it`s analysis

6. Conclusion

However, many a times the incorrect settings in the numerical relays have also become a cause of failure.

In the numerical relays of certain make, multiple protection starting triggers are provided and there is no provision of disabling any of them.

Large number of provisions are made in numerical relays, many a time Commissioning Engineers leave many setting on default due to time constraints or inadequate understanding of the consequences such left over settings causes mal operation of relays

CVT transients reduce the fundamental component of the fault voltage and cause distance relays to calculate a smaller than actual apparent impedance to the fault.

7. References

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