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MODERN NUMERICAL RELAY FOR POWER SYSTEM PROTECTION

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Abstract—**Modern power system is in the process of continuous development which has led it to complex interconnected networks. In today's environment, modeling the power system has become necessary in order for utilities to make the right decision when it embarks on any form of asset expansion. Modeling allows the proposed system to be checked for any potential problems, such as mal operation and incompatibility.**

The recent trend in protection has been a shift to Numerical protection techniques, thanks to the development using the single chip digital signal processors with high crunching capability, which has made it possible to design digital filters in real time. In the protection field, numerical techniques have got first application to line protection, and other complementary functions like fault locator, disturbance recorder & auto-reclosing. The present work describes latest salient features of the numerical protection technology, different multifunctional relays going to be installed in modern power system protection and their methods of protection.

Keywords-**Fault locator, bus bar, relay, over voltage, negative sequence current, etc.**

I. INTRODUCTION

As a consequence of deregulation, competition, and problems in securing capital outlays for expansion of the infrastructure, modern power systems are operating at ever-smaller capacity and stability margins. Traditional entities involved in securing adequate protection and control for the system may soon become inadequate, and the emergence of the new participants (non-utility generation, transmission, and distribution companies) requires coordinated approach and careful coordination of the new operating conditions. The power system components include synchronous machines, bus bars, transformers, transmission lines and distribution system consisting of complex and composite loads. However, during faults, voltage, current, phase angle, power or frequency quantities become abnormal and it is necessary that there must be a device which senses these abnormal conditions and the element or component wherein the abnormality has taken place is removed, i.e. it is isolated from the rest of the system as soon as possible.

II. MULTIFUNCTIONAL RELAY

The relays, which are associated with microprocessor and work on numbers representing instantaneous values of the signals such that current, voltage, frequency and power factor etc. are called numerical relays. These are also called digital relay, computer-based relay or microprocessor-based relay.

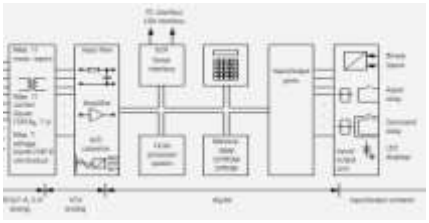

Figure2.1– Block diagram of multifunctional relay

These protection devices operate on the basis of numerical measuring principles. The analog measured values of current and voltage are calculated from the plant secondary circuits via input transducers. After analog filtering, the sampling and the analog to digital conversion takes place. The sampling rate is, depending on the different protection principles, between 12 and 20 samples per period. With certain devices (e.g. generator protection) a continuous adjustment of the sampling rate takes place depending on the actual system frequency. The numerical protection concept offers a variety of advantages, especially

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with regard to higher security, reliability and user friendliness.

III. RELAY FOR GENERATOR, MOTOR AND TRANSFORMER

Generator is a large machine and is connected to the bus bars. It is accompanied by the transformers, excitation system, prime mover, voltage regulator, cooling system etc. It is not single equipment, so protection of generator is the most complex. It is very expensive and important equipment as it should not be shut off as for as possible, because that will result in power shortage and emergency. These relays have been developed for small, medium and large power generation plants. They incorporate all the necessary protective functions and are suitable for the protection of Hydro and pumped storage generators, Cogeneration stations, Private power stations using regenerative energy sources such as wind or biogases, Power generation with diesel generators, Gas turbine power stations, Industrial power stations, Steam power stations.

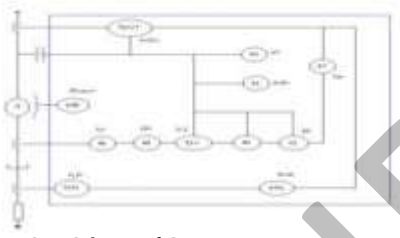

Figure 3.1- Scheme of Generator protection

Current Differential Protection

This function provides undelayed short-circuit protection for generators, motors and transformers, and is based on the current differential protection principle (Kirchhoff's current law). The differential and restraint (stabilization) current are calculated on the basis of the phase currents. Optimized digital filters reliably attenuate disturbances such as non-periodic component and harmonics. The high resolution of measured quantities permits recording of low differential currents (10% of IN) and thus a very high sensitivity.

By the harmonic analysis of the differential current, inrush (second harmonic) and over-excitation (fifth harmonic) are reliably detected, and unwanted operation of the differential protection is prevented. The current of internal short-circuits is reliably measured by a fast measuring stage (IDiff>>), which operates with two mutually complementary measuring processes.

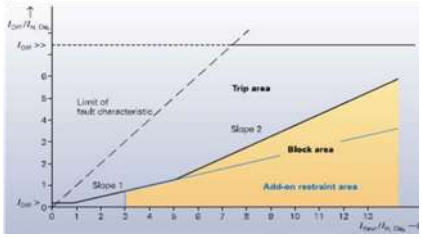

Figure3.2 - Current differential characteristic

IV. SCHEME FOR BUS-BAR PROTECTION

Bus-bars are a vital, often overlooked, part of the power system. These are the nerve Centre of power system where various circuits are connected together. They also known as the nodes of existing electrical circuits. Bus-bar faults are rare. The main function of the relay is bus-bar protection, and has the following characteristics:-

• Evaluation of differential currents, with stabilization by through currents. Independent bus-bar protection zones for bus-bars with up to 12 bus-bar sections and 48 bays.

• Very short tripping time (15ms Typical)

• Selective detection of short-circuits, also for faults on the transfer bus, with transfer trip to the remote end.

• Selective output tripping relays per feeder in bay units.

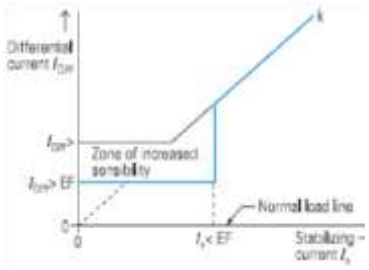

Figure4.1 - Sensitive earth-fault protection [10]

V. Modelling and Simulation Results

The Multifunctional generator relay model, which is developed using MATLAB Simulink, is tested under different fault condition at generator end. An algorithm for the relay model is given below

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Figure5.1 - Algorithm for generator relay

A three-phase system shown below consists of 15 kV, 50 Hz transmitting power from a synchronous generator with 250 MVA rating inter-connected to an 2500 equivalent source (substation) through a 200 km transmission line. The transmission line is split in two 100 km lines connected between buses of single generator and equivalent source. A three-phase system is modeled in continuous mode using blocks from three-phase library available in Simulink. Stator phase faults, over voltages, under-voltages and negative sequence current are protected with the developed relay model. Voltages and currents are measured in each condition. Stator phase faults protection all the stator phase faults including phase to ground, phase to phase and three phase faults are simulated. The protection against each fault is applied with the relay trip signal and opening of circuit-breaker. The simulation study also shows the normal operating condition and no trip signal from the relay under healthy condition.

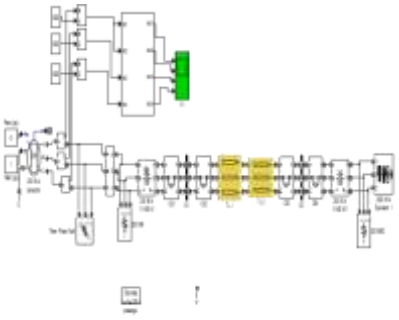

Figure 5.2 – Model used for system Operation when line to ground (AG fault) occurs

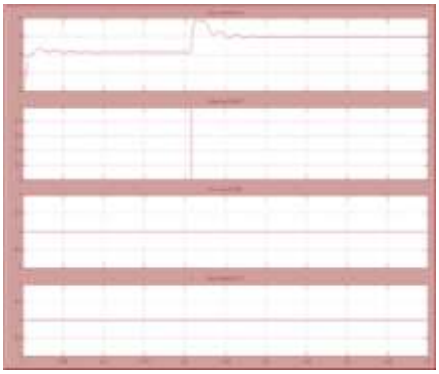

Figure 5.3- Line to Ground fault (AG fault)

II. CONCLUSION

From this study it can be concluded that combined relays should be used for protection and control. Relays with protection functions only and relays with combined protection and control functions are being offered. Relays support the "one relay one feeder" concept and thus contribute to a considerable reduction in space and wiring. With the development of digital technology modern protective relay supports both stand-alone and combined solutions on the basis of a single hardware and software platform. The user can decide within wide limits on the configuration of the control and protection functions in the line, without compromising the reliability of the protection functions. The following solutions are available within one relay family: Separate control and protection relays. Feeder protection and remote control of the line circuit-breaker via the serial communication link Combined relays for protection, monitoring and control.

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