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Modern Approach for Power System Protection Using MATLAB

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ABSTRACT: Recent power system is in the practice of continuous development which has leaded it to composite 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 feasible 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. Numerical generator, transformer and bus-bar protection have also been developed 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. Besides this, the thesis develops multifunctional generator relay model using MATLAB simulink which can protect the existing power system from the stator phase faults, over-voltages, under-voltages and negative sequence current.

KEYWORDS: Power System , Matlab

I. INTRODUCTION

The modern culture has come to depend heavily upon continuous and consistent supply of electricity and that too of a high quality. Computer and telecommunication networks, railway networks, banking and post office networks, continuous process industries and life support systems are just a few applications that just cannot function without a highly reliable source of electric power. And add to this, the mind-boggling number of domestic users of electricity whose life is thrown out of gear, in case the electric supply is disrupted. Thus, the significance of maintaining continuous supply of electricity round the clock cannot be overemphasized.

II. LITERATURE SURVEY

Power system protection is a fascinating subject. A protection scheme in a power system is designed to continuously monitor the power system to ensure maximum continuity of electrical supply with ideally zero damage to life, equipment and property.

G.H. Kijolle, O. Gjerde, B.T. Hjartsjo, H. Engen, L. Haarla, L. Koivisto and P. Lindblad in their work "Protection System Faults - a Comparative Review of Fault Statistics" .

H. Sato, T. Takano, S. Inoue, S. Oda, T. Anzai and N. Kusano in their work "A comprehensive approach for numerical relay system evaluation and test".

Z.Q. Bo, J.H. He, X.Z. Dong, B.R.J. Caunce and A. Klimek in their work "Integrated protection of power systems".

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III. FAULTS AND PROTECTION OF POWER SYSTEM

It is not practical to design and build electrical equipment or networks to eliminate the possibility of failure in service. It is therefore an everyday fact that different types of faults occur on electrical systems, however infrequently, and at random locations. Faults can be broadly classified into two main areas, which have been designated as 'active' and 'passive'

Active faults

The 'active' fault is when actual current flows from one phase conductor to another (phase-to-phase), or alternatively from one phase conductor to earth (phase-to-earth). This type of fault can also be further classified into two areas, namely the 'solid' fault and the 'incipient' fault.

Passive faults

Passive faults are not real faults in the true sense of the word, but are rather conditions that are stressing the system beyond its design capacity, so that ultimately active faults will occur.

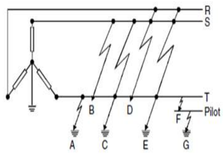

Figure 3.1 :- Types of fault on a 3 phase system (A)Phase to earth fault (B) Phase to phase fault (C) Phase to phase to earth fault (D) Three phase fault (E) Three phase to earth fault (F) Phase to pilot fault* (G) Pilot to earth

It will be noted that for a phase-to-phase fault, the currents will be high, because the fault current is only limited by the inherent (natural) series impedance of the power system up to the point of fault (Ohm's law). By design, this inherent series impedance in a power system is purposely chosen to be as low as possible in order to get maximum power transfer to the consumer so that unnecessary losses in the network are limited thereby increasing the distribution efficiency. Hence, the fault current cannot be decreased without a compromise on the distribution efficiency, and further reduction cannot be substantial

IV. MULTIFUNCTIONAL RELAY

Introduction

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. The modern numerical relay provides more than one primary protection functions, so they are also named as multifunctional relay.

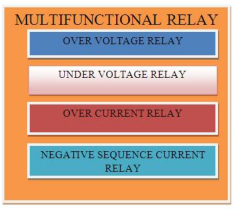

Figure 4.1 – Block diagram of multifunctional relay

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

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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.

V. MODELLING AND SIMULATION RESULTS

Model discription

The Multifunctional relay model, which is developed using MATLAB simulink, is tested under different fault condition at generator end. 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.

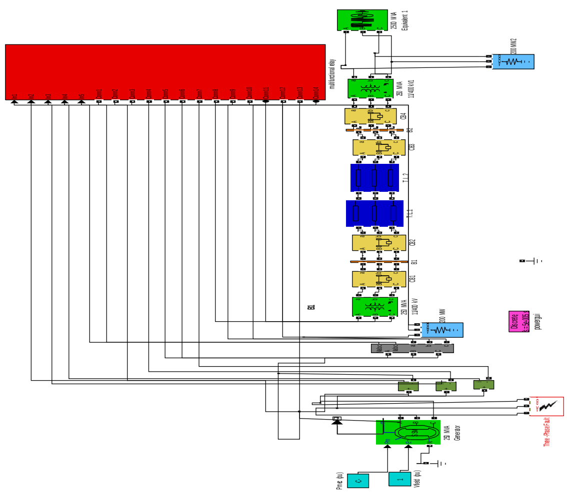

Figure5.1 – Model of used system

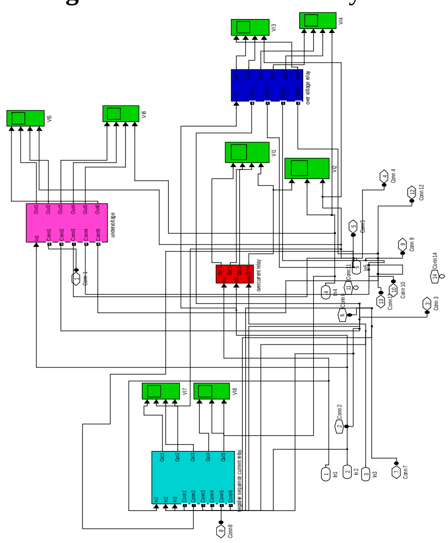

Figure5.2 – Model of Multi-functional relay

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Modeling of undervoltage relay

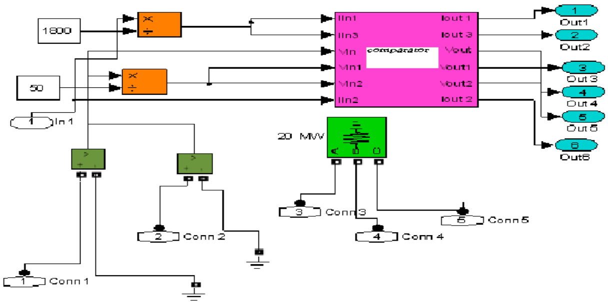

Figure5.3 – Model of under voltage relay

Figure is showing the modeling of under voltage relay. In this model a comparator is used to compare the rms values of the signal with the standard values

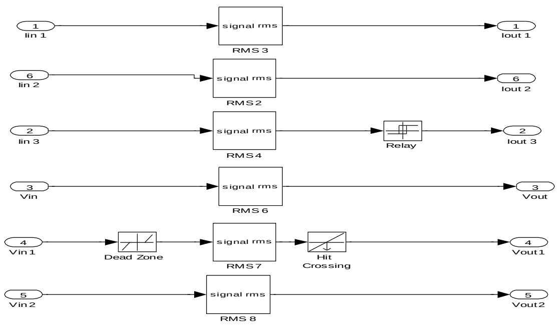

Figure5.4 – Block diagram of comparator

Figure 5.4 is showing the behavior of under voltage relay when fault occurs in only one phase (phase A). In this figure the waveforms of rms value of current, relay current, current relay signal and phase current of all phases are shown.

VI. SIMULATION AND RESULTS

We have simulated the discussed model under phase faults, abnormal conditions (under voltage and over voltage) and Negative sequence current conditions and found successful results of used relays.

When fault occurs in only one phase (phase A):-

We have introduced a fault on phase A and in this condition the performance of used relays are as follows.

(a) Under voltage relay:-

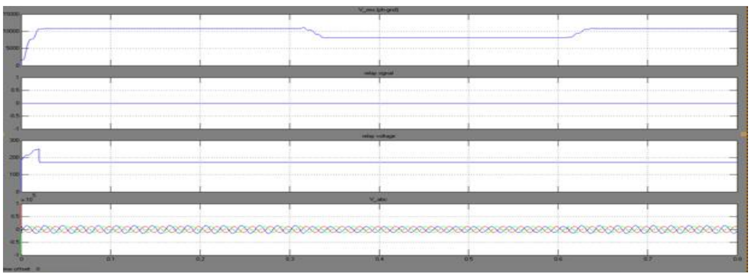

Figure – Waveforms of under voltage relay

Figure is showing the behavior of under voltage relay when fault occurs in only one phase A.

When fault occurs in two phases (phase B and phase C)

We have introduced a fault on phase B and phase C and in this condition the performance of used relays are as follows.

Under voltage relay:-

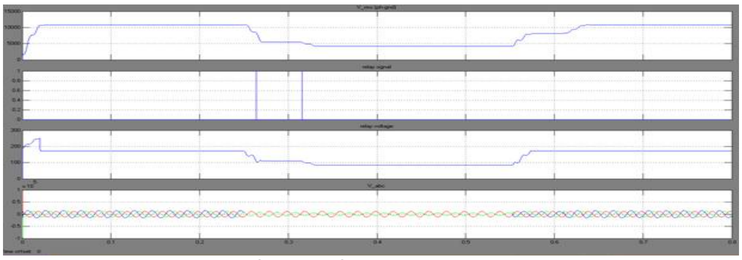

Figure – Waveforms of under voltage relay

Figure 5.15 is showing the behavior of under voltage relay when fault occurs in two phases (phase B and phase C)
Figure 5.15 is showing the behavior of under voltage relay when fault occurs in two phases (phase B and phase C). In this figure the waveforms of rms value of current, relay current, current relay signal and phase current of all phases are shown.

VII. CONCLUSION AND FUTURE SCOPE

Conclusion

From this study it can be concluded that combined relays should be used for protection and control. In transmission type substations, separation into independent hardware units is still preferred, whereas on the distribution level a trend towards higher function integration can be observed. Here, combined feeder/line relays for protection, monitoring and control are on the march. 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.

Future scope

Today the need for continuous and reliable power supply has increased. So, the protection for the power system is very necessary with lower cost and easy handling. Now the age of multifunctional protective relay has come. It can supervise the whole protection of one equipment.

Using MATLAB simulink, a system has been developed for multifunctional relay scheme which protects the generator against the stator phase faults, overvoltage, under-voltage and negative sequence current condition. This relay system can be further implemented for the development to multi-functionalize the bus-bar, transformer and distance protection. Besides this the modern switchgear with vacuum circuit breaker is also being developed. This will be very interesting area to be studied further.

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