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A Power System DG Protection and Power Scheduling Using Breaker Triggering Time Controlling

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Abstract- Modern electrical power system is spreaded over large geographical area with great complexity. Power quality requirements resulting from such great complex electrical network have motivated the improvement of fault location methods and development of protection scheme for grid. Grid is a vital, often overlooked, part of the power system. Even though faults on grid are very rare, they can lead to disturbances & major shutdown of power system network. Thus, protection of grid requires highly reliable, fast and high speed relaying scheme. With the fast changing technologies in the field of grid protection, new protection concepts addressing new technologies are coming to the market.

Keywords- PID Controller, Power System Stabilizer (PSS), Synchronous Generator.

I. INTRODUCTION

There is an urgent need to keep track of different past and present relaying techniques, international standards, design and service experiences of digital/numerical relays and recent algorithmic developments taking place in the field of grid protection. This chapter gives a bibliographical survey, comprehensive review of different grid relaying schemes and conceptual aspect of research and developments in the field of grid protection during the past 50 years, based on numerous published articles. Different grid protection techniques have been studied and a comparative evaluation of them is undertaken with their relative advantages and disadvantages for identification of optimum technique as applied to specific bus configuration [1, 2, 3, and 4].

II. GRID AND PROTECTION REQUIREMENT

Protection engineer try to implement a dedicated bus zone protection scheme from the various schemes developed by researchers. If it is not implemented perfectly, the clearing of bus fault will be performed by the backup protection provided to the lines terminating at the bus. The high fault levels associated with a grid require fast protection. Typical fault clearing time should be less than 100 ms; with fast breakers, this means that the measuring time should be about 20 to 30ms.

The prime requirement of the grid protection scheme is the identification of fault in a particular region and disconnection of circuit breakers associated with that particular region so that healthy section of power system network remains unaffected. This discriminating feature of the grid protection scheme minimizes interruption of the plant. Hence, it is justified that discrimination on the basis of time graded relays is not a good choice, and hence, there is a need to develop genuine protection scheme for the grid. Grid protection scheme should not operate for any external (through) fault, as otherwise it unnecessarily trips other healthy lines connected to the bus. This is a very important feature of the grid protection scheme with respect to the stability of the power system [5].

It is to be noted that all these requirements cannot be achieved completely by any of the schemes without affecting the other requirements. Therefore, there is always a compromise between many factors such as speed versus selectivity and stability versus dependability. Whenever bus fault occurs, it results in severe disturbances as clearance of this fault requires tripping of all the breakers of the lines connected to the faulted bus. Moreover, the danger caused because of unprotected bus during bus fault is found to be very severe.

Thus, in order to prevent hazard to the system, grid protection scheme is designed and implemented in such a way that unwanted tripping should not occur. By involving bus sectionalizer and different bus arrangement, the number of circuits that must be opened for a bus fault is minimized and hence, eliminating total interruption of power [6].

Bus faults have been observed to be relatively rare around 8% of all faults compared with line faults which are over 60% [7], [8,9,10], [3]. It has been observed from the widely published literature that most of the bus faults are ground faults having 67% are single line to ground faults, 15% are double line to ground faults and 19% are triple line to ground faults [6].
Grid fluctuation can be broadly classified as:

- Fault due to insulation failure caused from damaged CBs or insulators
- Arcing and insulator flashover caused by over voltages

- Faulty handling of switching equipments especially earthing switch
- Dropping off of metal parts across grids

Thus, the protection provided must possess the following characteristics

- It is fast enough to minimize damage and maintain system stability
- It provides correct operation during an internal fault
- It maintains stability by avoiding operation in case of an external fault
- It supervises all CTs, which provides actuating quantity to the relay in case of fault.

III. NON-UNIT PROTECTION SCHEME

The non-unit protection scheme is governed by back-up over current, earth fault and distance relays. The high fault levels associated with grids require that protection must be very fast. Typical fault clearing time should be less than 100 ms and with fast breakers it should be about 15 to 30 ms [8]. In order to minimize the interruption of the plant the protection system must correctly identify the area of the fault and open only the necessary and minimum number of breakers.

However, because of speed requirements, these relays are usually found to be non-discriminative and slow in operation. Further, the vagrancy of the scheme applied to grid protection can cause unnecessary tripping when relay spuriously trips thereby causing discontinuity of supply. In addition, it can cause havoc to equipment if back-up relays do not operate quickly. Hence, the philosophy of back-upprotection to clear grid faults can be confined to radial system only. It is therefore preferable to have a clearly defined grid protection scheme such as unit protection scheme which will be discussed in the next sub-section.

1. Unit Protection Scheme:
Unit protection scheme is a scheme that operates for a fault within its zone. Here, zone of protection is decided on the basis of current transformers (CTs), and it includes each and every fault point inside the CTs where measurement of currents is carried out. This type of protection scheme is widely used in grid, generators, transformers, and large induction motors. Differential and directional comparison protection scheme is the best example of this type of protection scheme.

2. Directional Comparison:
When it is not economical to change out or add new current transformers then bus fault protection is achieved by directional comparison scheme using the existing line CTs. The main theme of this scheme is that if the power flow in one or more circuits is away from the bus, an external fault exists whereas for the power flow in all of the circuits into the bus, an internal bus fault exists [2].

This scheme is categorized in three parts namely Series Trip Directional Scheme, Directional Blocking Scheme and Directional Comparison Scheme.

IV. PROPOSED METHODOLOGY

A good electric power system should ensure the availability of electrical power without any interruption to every load connected to it. Generally power is transmitted through high voltage transmission line and lines are exposed, there may be chances of their breakdown due to storms, falling of external objects, and damage to the insulators etc. These can result not only mechanical damage but also in an electrical fault. Protective relays and relaying systems detect abnormal conditions like faults in electrical circuits and automatically operate the switchgear to isolate faulty equipment from the system as quick as possible.

This limits the damage at the fault location and prevents the effects of the fault spreading into the system. The switch gear must be capable of interrupting both normal currents as well as fault current. The protective relay on the other hand must be able to recognize an abnormal condition in the power system and take suitable steps so that there will be least possible disturbance to normal operation. Relay does not prevent the appearance of faults. It can take action only after the fault has occurred. However, there are some devices which can anticipate and prevent major faults. For example, Buchholz relay is capable of detecting the gas accumulation produced by an incipient fault in a transformer.

1. Nature and Causes of Power Fluctuation:
The nature of fault simply implies any abnormal condition which causes a reduction in the basic insulation strength between phase conductors, between phase conductor and earth or any earth screen surrounding the conductors. The reduction of the insulation is not considered as a fault until it produces some effect on the system i.e. until it results either in an excess current or in the reduction of the impedance between the conductors, between the conductor and earth to a value below the lowest load impedance normal to the circuit. Power systems mainly consist of generator; switch gear, transformer and distribution system. The probability of failure is more on the power system due to their greater length and exposure to atmosphere.

1.1 Breakdown at normal voltage may occur on account of:

- The deterioration of insulation
- Damage due to unpredictable causes such as perching of birds, accidental short circuiting by snakes, tree branches, etc.

1.2 Breakdown may occur because of abnormal voltages: This may happen because of

- Switching surges
- Surges caused by lightning

The present practice is to provide a high insulation level of the order 3 to 5 times the normal voltage, but still:

- The pollution on an insulator string caused by deposited soot or cement dust in industrial area.
- Salt deposited wind borne see spray in coastal area.

These will initially lower the insulation resistances and causes a small leakage current to be diverted, thus hastening the deterioration. Secondly, even if the insulation is enclosed, such as sheathed and armoured, the deterioration of the insulation occurs because of:

- Ageing
- Void formation in the insulation compound of underground cable due to unequal expansion and contractions caused by the rise and fall of temperature.

Thirdly, insulation may be subjected to transient over voltages because of switching operation.

- The voltage which rises at a rapid rate may achieve a peak value which approaches three times phase to neutral voltages.
- Lightning produces very high voltage surges in the power system in the order of million volts. These surges travel with the velocity of light in the power circuit. The limiting factors are the surge impedance and the line resistance [1].

2. Consequences of Power Fluctuation:

Serious results of the uncleared fault, is fire which may not only destroy the equipment of its origin but also may spread in the system and cause total failure. Consequences;

- A great reduction of the line voltages [7].
- Damage caused to the element of the system by the electrical arc.
- Damage to other parts due to overheating.
- Disturbance to the stability of the electrical system and this may even lead to a complete shutdown of the power system.
- Reduction in the voltage may fail the pressure coil of the relay [8].
- Considerable reduction in the voltage on healthy feeder connected to the system having fault. This may cause either an abnormally high current being drawn by the motor or the operation of no volt coils of the motors. (Considerable loss of industrial production as the motors will have to be restarted) [9].

V. RESULT AND ANALYSIS

1. MATLAB 2015A Simulation:

For proposed relay time controlling to simulating MATLAB 2015 simulation software. In this Simulink designing used power library components.

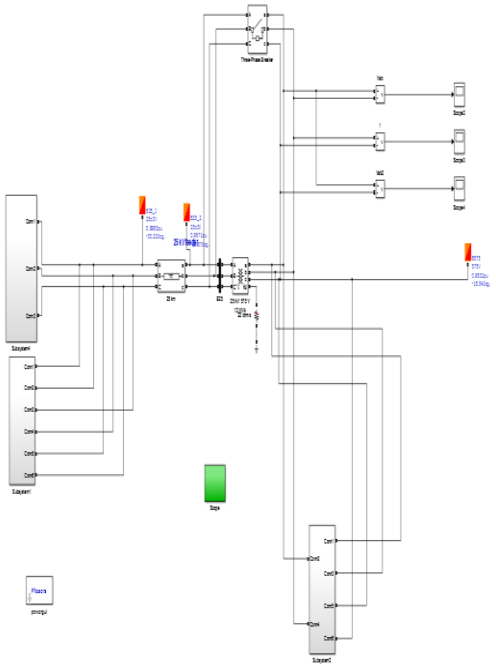

Fig 1. Proposed Simulink models in MATLAB 2015 a software.

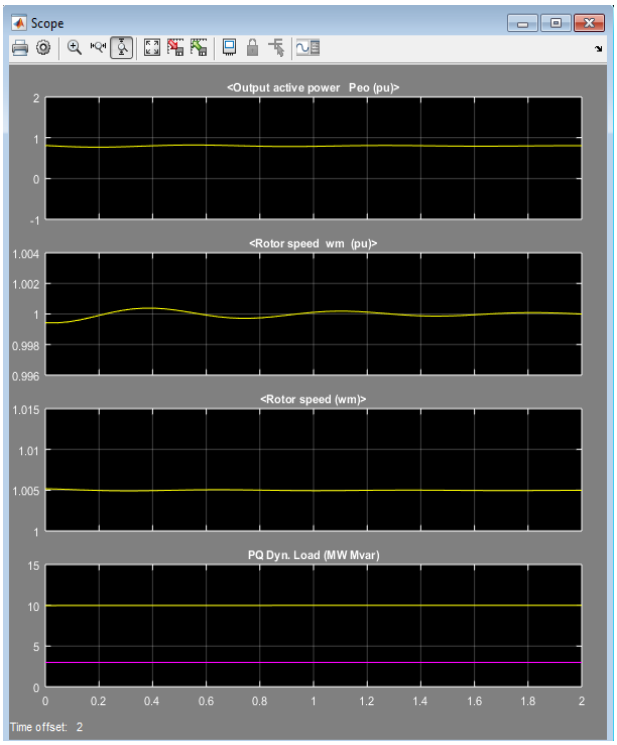

Fig 2. Power stabilizations.

Fig. 1 is show Simulink simulation model of MATLAB software and consisting of library components.

Fig. 2 power stabilizations curve for graph fitting MATLAB toolbox. In this figure X axis are shows Time and Y axis of constant Amplitude of power using Relay.

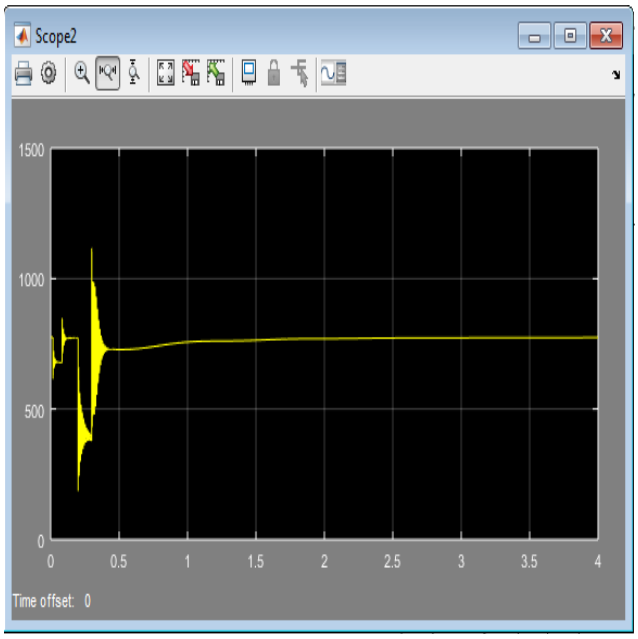

Fig 3. Active Voltage variation.

Fig. 3 Active voltage variation graph with respect to time with different color indicates different level of voltage variation. In this figure X axis is shows Time and Y axis of Active variation.

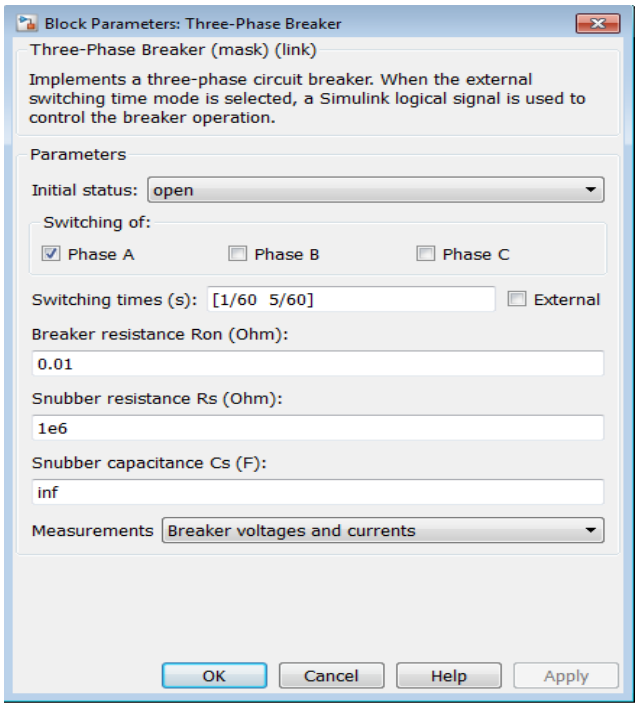

Fig 4. Breaker GUI.

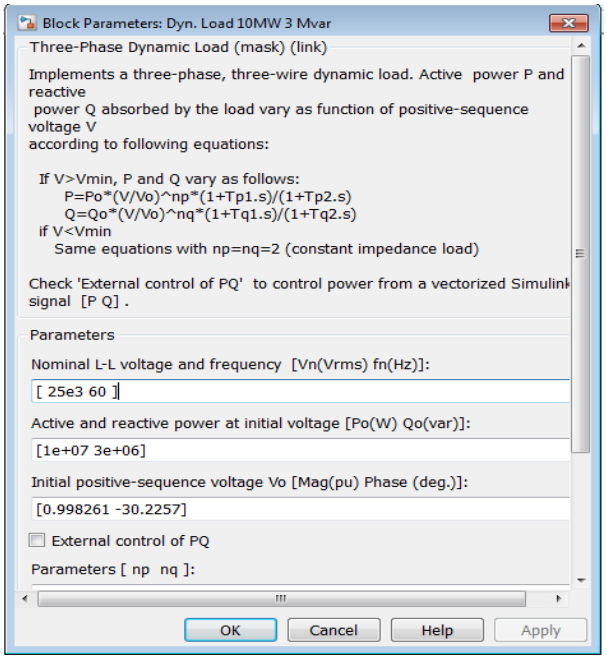

Fig 5. Dynamic Load.

VI. CONCLUSION

Modern protection and control of power system have been made more robust than the conventional type through the use of pmu which has reduced the time lag between the measured system state and the time these system states are sent to the control centers for procession. The incorporation of PMU has to the adaptation of real time self healing system which has definitely easy off some of the operator's control job with great improvement in speed and precision.

The dynamic system assessment which in this modern protection and control are been done on – line rather than offline simulation and have led to operation of power system closer to their limits with its attendant economical advantage especially in this modern world embraced with deregulated power system environment. The time stamped PMU data other known as synchronized PMU data offers opportunities for more efficient wide area protection and control as such some stubborn protection like the protection of series compensation lines and likes are better handled in this new protection and control dispensation.

VII. FUTURE SCOPE

For further work of relay controlling used AI algorithm like as CNN (convolution neural network) and SVM automatically minimization of triggering time period.

In future can be modified to operate as a multi-relay device, i.e. the same processor can have an increase in input sensors to sense voltage and current signals from

different grid buses and an increases in output port to trip different relays according to co-processor numerical relay logic. This will lead to replacement of many relays by a single co-Processor Numerical relay.

The relay can be modified to act as a multi-relay device, i.e., with the same processor, the number of input sensors and output ports can be increased to sense current as well as voltage signals from different grid buses and trip different relays according to the FPGA logic. Therefore, one unit of the modified FPGA relay can replace a huge number of relays with the same settings of the replaced relays.

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