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OPTIMAL RECLOSING TIME TO IMPROVE TRANSIENT STABILITY IN DISTRIBUTION SYSTEM

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The power sector is focused on distributed generation due to improvements in new technologies such as fuel cells, wind turbines, and solar (DGs). DGs have received a lot of attention in the electrical industry as a consequence of market liberalisation and environmental concerns. For the IEEE nine bus system with DG connection, this is the optimal circuit breaker reclosing. The most cost-effective reclosing process is decided by the total amount spent. Angles of DG load The optimal reclosing times are computed first, and then the performance of the recommended system is assessed. The traditional and contemporary approaches of reclosing are compared. There are both transitory and permanent faults at this location. Several aspects in the power system model are considered. Two performance indices are employed to evaluate the system. The recommended technique offers major advantages for online application computation since it needs fewer data. To validate the recommended method, a simulated study using MATLAB/SIMULINK is utilised. Simulations demonstrate that the proposed method is capable of calculating the optimal reclosure time and system improvement. Furthermore, the proposed technique outperforms the usual way of reclosing.

Key Words: Auto-reclosing, Fault, Transient Stability, Alternative Transient Program/Electromagnetic Transient Program.

1. INTRODUCTION

Concerns about the environment and the economy have prompted a major growth in the development of distributed generation (DG). The technical characteristics of distribution systems may be influenced by the implementation of these generations. The operation of DG may result in unintended protection operation, as well as a change in the fault level. The influence of DG on transient stability cannot be overlooked as the penetration level of DG increases.

Transmission and distribution networks confront several challenges in terms of trip and closing decisions on each line, as well as their implications for network stability. The network's dependability can be improved by a successful automated closure back in decision to a line. Distribution lines, transmission lines, and circuit

breakers that have been damaged by electrical faults may be recovered via auto reclosing. Successful auto reclosing may improve power system transient stability and reliability.

However, if the auto reclosing fails, the system may become unstable, resulting in system and equipment damage. Because DG may continue feeding fault current throughout the auto reclose open period, preventing the anticipated arc extinction, the presence of DG can result in failure auto reclosing. As a result, the authors of recommend that the DG be explicitly detached before to the reclosing. The frequent disconnection of DG, on the other hand, may result in a reduction in power quality, such as outages and voltage sag. Reconnection after DG separation may also result in secondary transients in distribution networks.

Electrical power swings normally follow the fault's clearing occurrence. These fluctuations are potentially dangerous since they may deceive distance protection and cause generators to overheat. When a huge quantity of electrical power oscillates, the aforementioned impacts may cause cascading line failures, network equipment out of sync, and finally transient instability. As a result, avoiding harmful power swings is critical. The ideal reclosure time is critical for reducing system oscillations and improving transient stability. Using a simple equation based on statistical data, a typical reclosing scheme displays the reclosing of circuit breakers after a set time period when the arc extinction.

$$T_{arc} = (10.5 + \mathrm{kV}/34.5) \text{ cycles} \qquad (1)$$

The line voltage is denoted by kV. Only the line voltage is taken into consideration in this calculation. As a result, if the value computed by (1) is not correct, the circuit breaker will not be able to reclose effectively, indicating that the system is in an unstable condition. Because transient stability is determined by the state of the generators, we must determine an optimum reclosing time (ORT) at which circuit breaker reclosing would effectively improve the system's transient stability.

ORT was given in the article based on the DGs' total load angles. The ORTs are calculated first, and then the suggested reclosing scheme's performance is compared to that of the traditional reclosing method. The ability of the suggested technique is shown by considering both transient and persistent defects at various places in the power system model. We can preserve transient stability by using the given approach.

2. LITERATURE REVIEW

Ahmed R. Adly , Ragab A. El Sehiemy , Almoataz Y. Abdelaziz et.al: The power industries have paying their attention on distributed generations (DGs) due to the improvement in new technology like fuel cell, wind turbine, and photovoltaic. Hence, DGs have attained a lot of consideration in the power industry due to market deregulations and ecological concerns. This study presented the optimal reclosing of circuit breakers for the DG connected IEEE nine bus system. The optimal reclosing technique is derived from the total load angles of the DGs. First, the optimal reclosing

times are determined, and then the performance of the proposed reclosing method is compared with the conventional reclosing technique. Both transient and permanent faults at different points in the power system model are considered. Two indices are considered to evaluate the system performance. The proposed technique has a significance merits for online application due to its less amount of calculation. The proposed method is verified by a simulation study using MATLAB/SIMULINK. Simulation studies demonstrate that the proposed technique is able to determine the optimal reclosure time and enhancing system stability. Moreover, the performance of the proposed method is better than that of the conventional reclosing method.

San Thiri Aung et.al: `states that the analysis of suitable setting for optimal reclosing Time for 230kV KamarnatMyaungtagar line. The reclosing time is to reclose circuit breaker (CB) followed by a time delay after CB had tripped for restoring the system to normal as quickly as possible without regard to the system conditions. This time is made up of the circuit breaker time plus the system electrical dead time. Autoreclosure provides a means of improving power transmitting ability and system stability. Conventional auto-reclosing of circuit breakers adopts the fixed dead time interval which can affect the stability and power quality of the system. Circuit breaker should be reclosed at an optimal reclosing time to enhance the transient stability when the system disturbance has no effect after reclosing operation. Both transient and permanent fault in the power system model are considered. The optimal reclosing time is verified by simulation study using Alternative Transient Program/Electromagnetic Transient Program (ATP/EMTP).

Hun-Chul Seo , Hyun-Soo Park, Sang-Min Yeo, Chul-Hwan Kim et.al: An autoreclosing is used for the purpose of restoring the power system after a trip of the circuit breaker. The successful autoreclosing can enhance stability and reliability of the power system. The distributed generation (DG) is the small and medium size generator connected to distribution system. Because of the efficiency and productivity of the DG, the integration of DG to the distribution system will be increasing. On the other hand, it may cause the many problems of power system. For example, the maloperation of protective relay by distributed generation may be occurred. This paper analyzes the effects of reclosing according to size of DG, and suggests adaptive reclosing algorithm considering DG. The proposed algorithm consists of angle oscillation's judgment, Emergency Extended Equal-Area Criterion (EEEAC), calculation of optimal reclosing time, and reconnection algorithm. The algorithm is implemented by ATP/EMTP-MODELS. The simulation results show that the transient stability is maintained and the distributed generation is protected against disturbance.

Hun-Chul Seo and Chul-Hwan Kim et.al: Autoreclosing techniques have been used in power systems to maintain system stability and continuity of supply. Environmental and economical issues have driven significant increases in the development of distributed generation (DG). DG connected to distribution

systems, however, may impose negative influences with respect to power quality, protection, and stability, because DG can cause some challenges to protection, especially to reclosing. For this reason, in order to improve the reliability and safety of the distribution system, the rules and guidelines suggest that the DG system needs to be rapidly disconnected from the system before reclosing. We present, in this paper, an adaptive reclosing algorithm considering the DG. The algorithm consists of an angle oscillation's judgment, the emergency extended equal-area criterion (EEEAC), the calculation of an optimal reclosing time, and a reconnection algorithm. Our simulation results for three different DG technologies with Electromagnetic Transient Program (EMTP) indicate that we can maintain transient stability while the DG is protected against disturbances.

3. THE FUNDAMENTAL IDEA BEHIND ADAPTIVE OPTIMUM RECLOSURE

Traditional auto reclosing may have an influence on system stability since it is dependent on the generator state of reclosing instances. To improve the system's transient stability, circuit breakers should be closed at an ORT where the system disruption has no influence after reclosing operation. The ORT is the point at which all of the following requirements must be satisfied. The point at which the system is least disrupted without necessitating reclosing [6].

Recent proposed solutions for identifying permanent from transient faults [7, 8], preventing autoreclosers from reclosing onto persistent faults, seem to be effective. It's also occasionally inevitable to emphasise on recurring faults.

4. AUTORECLOSING

Auto-reclosing is a critical technology for restoring faults quickly, improving system stability, and preventing power supply disruptions. Auto-reclosing is a cost-effective and efficient approach for improving the dependability and stability of high-capacity electric power networks. When auto-reclosing is effectively implemented, the system's stability is typically restored, and electric power transmission is maintained. After tripping, give enough time for the fault arc to de-energize before reclosing; otherwise, the arc will re-strike. The auto-reclose scheme's goals are to improve medium-voltage supply continuity while also maintaining system stability and synchronisation.

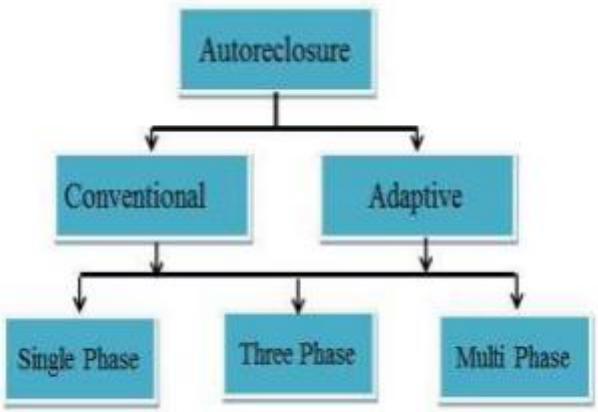

Fig 1:Type of Auto reclosure

A. Conventional Auto reclosure:

After a predetermined period after tripping operation, conventional reclosure uses a defined time interval technique to return the system to normal as rapidly as feasible,

regardless of system circumstances (permanent or temporary fault). It is impossible to predict whether or not reclosing would be effective.

B. Adaptive Autoreclosing

Adaptive autoreclosures don't reclose persistent faults and only reclose transient faults when the secondary arc has gone out. This is a new technique that incorporates variable dead time, optimum recloser, and phase by phase recloser to increase power system marginal stability during faults. The following are some of the benefits of autoreclosing: - Reduced failed reclosing, - Improved transient stability margins, - High-speed reaction to sympathy trips, and - Reduced system and equipment shocks

C. Application of Autoreclosing

The following are the most crucial parameters of an auto-reclose scheme: [3]

- Downtime

- Take back control of your time - Single or several shots

The interval between the activation of the auto-reclose scheme and the completion of the circuit breaker closing contactor is known as dead time.

The period between the closing contact on the auto-reclose scheme relay and the completion of another circuit inside the auto-reclose scheme that will reset or lock out the scheme or circuit breaker as necessary is known as reclaim time.

The number of tries at reclosing that an auto-reclose scheme will make before locking out on a permanent defect is referred to as the number of shots. The amount of shots may be set or changed.

5. Optimal reclosing procedure based on load angle

Traditional autoreclosing of circuit breakers may degrade system stability and power quality since it is dependent on the behaviour generator state of reclosing occurrences. The circuit breakers should be closed at an ORT where the system disturbance has no effect after the circuit breakers are reclosed to enhance transient stability. Real-time measurement is required to obtain the optimal reclosure time. The optimal reclosure unit kicks in after the circuit breakers have tripped in the case of a breakdown. The recommended approach is shown in Figure 2. The ORT technique entails the following steps: the load angles of the generators G1 and G2 must be recorded, and the total load angles may then be determined using the global positioning system (GPS). The ORT is defined as the minimum total load angle oscillation of the generators without reclosing operation. Figure 2 depicts the functional block diagram of the aforementioned optimal reclosing. Traditional autoreclosing of circuit breakers may degrade system stability and power quality since it is dependent on the behaviour generator state of reclosing occurrences. The circuit breakers should be closed at an ORT where the system disturbance has no effect after the circuit breakers are reclosed to enhance transient stability. Real-time measurement is required to obtain the optimal reclosure time. The optimal reclosure unit kicks in

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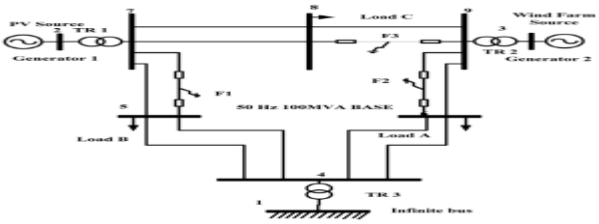

Fig 2: DG connected IEEE nine-bus system model

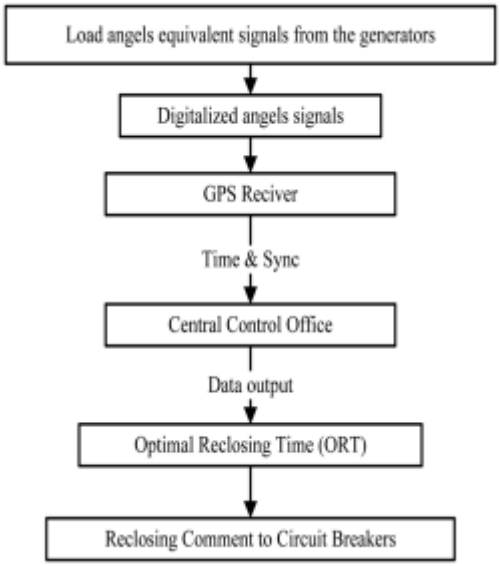

Fig 3: Flowchart of the proposed ORT scheme

scheme, including GPS. Using the computer, the central control office can then detect the ORT readily. The behaviour of the proposed method is estimated by using the voltage and speed indices. The lower indices values imply that the higher the system's performance is

$$V_{\text{index}} = \int_0^T |\Delta V| \, dt \qquad (2)$$

$$W_{\text{index}} = \int_0^T |\Delta W| \, dt \qquad (3)$$

where, ΔW and ΔV are the deviation of the speed and voltage of the generators from their steady-state values. The ΔW and ΔV are expressed as:

$$\Delta W = W - W_0 \qquad (4)$$

$$\Delta V = V - V_0 \qquad (5)$$

where, W and V are instantaneous values of speed and voltage, respectively, and the W0 and V0 are steady-state values of speed and voltage, respectively.

6. RESULTS AND DISCUSSION

The values of the first ORT of various fault sites for transient and permanent faults are computed using the suggested technique and are shown in Table 1 as the sum of the load angles. The total of the load angles for the 3LG (three phase-to-ground) transient fault at F1 is shown in Fig. 3 without the ORT being calculated. In the system model, fault sites F1, F2, and F3 are employed. The new approach and the traditional way are both effective.

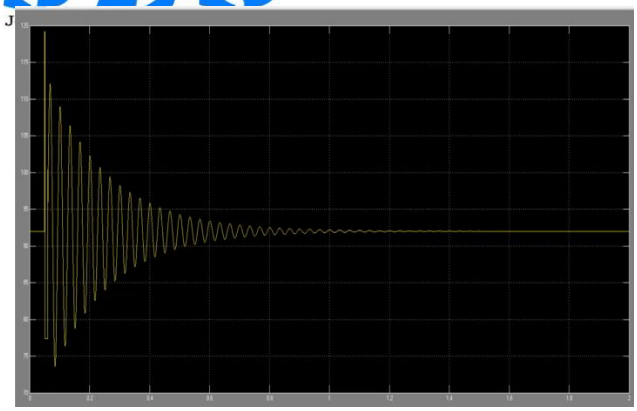

Fig 4: Total load angles response for determining ORT

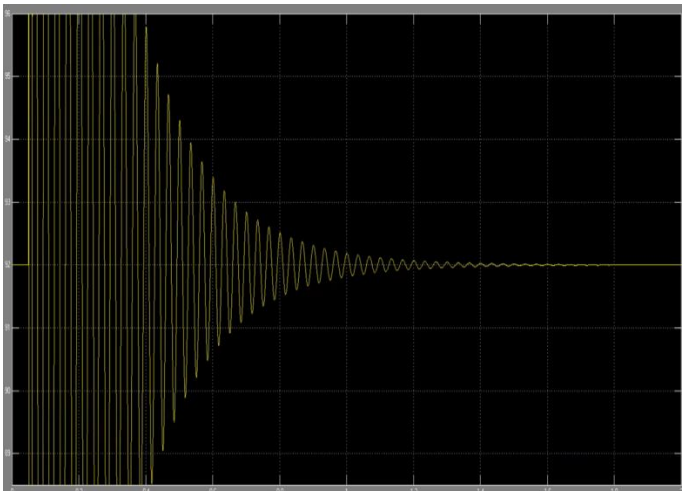

Fig 5: Response of the speed for LLLG and LG transient

CONCLUSION

A method to determine ORT has been presented. The method depends on the synchronous generators load angles and predicts ORT for enhancement power system stability. The proposed scheme is verified by simulation study using MATLAB/ SIMULINK. Simulation studies demonstrate that the proposed scheme is able to determine the optimal reclosure time and enhancing system stability. The lower voltage and speed indices values for the proposed method compared with the conventional method indicate better system's performance. The advantages of the proposed method are summarised as follow:

- Enhancement transient stability.
- The execution of the proposed reclosing scheme is better than that of the conventional reclosing scheme.
- The significance of this scheme is that it can be implemented for online application because there is no need for relevant large amount of calculation.
- Does not need any artificial intelligent techniques.

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