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A Review Article of a Solar Power Generation and Fault Effect Analysis in Matlab

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Abstract- In the recent years the detection as well as the identification of various faults in the Photovoltaic (PV) system applications has been attracting several researchers across world. Photovoltaic (PV) power generation systems are very good in working with several climatic outdoor conditions, Hence the present faults can see to occur within the PV arrays in PV systems. Online fault detection for the PV arrays is important to improve the system's reliability, safety and efficiency. There are some researches shows the working of the potential faults in order to monitor the faults as well as to make identifications through fault diagnosis that have been elaborated in order to develop and to modify the present problems solving method so to detect early faults in Photovoltaic (PV) system present in the system operators. In this paper author tries to put information precisely taken forward from previous research. The author also explains about the latest trends applied in the PV system fault diagnosis as well as protection system. In this paper a new approach towards literature has been introduced associated with the fault studies present in the PV systems. In this survey paper author has explained about further discussions over how specific solutions can be provided to make a comprehensive solution to the fault problems of the PV system.This paper presents the classification and detection of faults in a distributed generation, particularly Photovoltaic (PV) Grid-Connected system. The initial step in fault detection of PV system is recognition, investigation and classification of all possible faults that maybe occur in the system.

Keywords- Detection and Identification, Fault Diagnosis, Monitoring Systems, Protection Systems, PV Systems.

I. INTRODUCTION

A solar photovoltaic (SPV) system alters the solar light energy into electrical energy. The SPV system comprised of solar panel(s), charge controller (CCR) or inverter, battery bank (optional), electrical and mechanical appliances (1–3). The energy produced is either stored in a battery bank in an off-grid system or fed to the grid for supply through an on-grid or grid-tie technology. Inverters act as a brain of any SPV system.

The grid-tie inverter alters direct current (DC) into a required alternating current (AC) for adding into an electrical power grid. Other inverter application includes; wind turbines and micro turbines, variable frequency drives, High voltage direct current (HVDC) power transmission and uninterruptable power supply. Modern inverters use solid state designs with microprocessor control to produce high quality AC power very efficiently. To feed electrical power competently and securely into the grid, grid-tie inverters must be synchronized with the healthy voltage, frequency and phase of the grid. Grid-tie inverters are also aimed to quickly detach from the grid if the utility grid become unserviceable. The grid tie inverter shuts down to prevent the energy it transfers from harming any line workers working on the power grid [1-5].

II. FAULTS PROTECTION FOR DISTRIBUTED GENERATION

Faults detection for the protection of distributed generator fed systems that have been tested on power distribution busses of 25 kV and less. Recent interest in distributed generator installation into low voltage busses near electrical consumers has created some new challenges for protection engineers that are different from traditional radially based protection methodologies.

Therefore, typical protection configurations need to be re-thought such as re-closures out-of-step monitoring, impedance relay protection zones with the detection of unplanned Faults of distributed generator systems. The condition of Faults, defined as when a section of the non utility generation system is isolated from the main utility system, is often considered undesirable because of the potential damage to existing equipment, utility liability concerns, reduction of power reliability and power quality [6-15].

Current Faults detection methods typically monitor over/under voltage and over/under frequency conditions passively and actively; however, each method has an ideal sensitivity operating condition and a non-sensitive

operating condition with varying degrees of power quality corruption called the non detection zone (NDZ). The Faults detection method developed in this thesis takes the theoretically accurate concept of impedance measurement and extends it into the symmetrical component impedance domain, using the existence of naturally and artificially produced unbalanced conditions.

Specific applications, where this Faults detection method improves beyond existing Faults detection methods, are explored where a generalized solution allows the protection engineer to determine when this method can be used most effectively. To start, this thesis begins with a brief introduction to power systems in North America and the motivation for the use of distributed generation. Further chapters then detail the background and specifics of this technique.

III. LITERATURE REVIEW

Zhang Baohui, The mathematical model for analysis the effects of reclosure interval time on power system stability: This paper discuss the influence of the reclosure time on the stability of electric power systems, establishes a mathematical model and derives the optimum condition of reclosure about transient and permanent faults using the energy function. Emulation calculations show that reclosing at optimal time will improve the stability margin, transmitted power and the transient stability greatly. It lays the foundation of reclosing time setting and the study of the optimal reclosure.

Xin Cui, Experimental Research on Typical Single-Phase High Resistance Grounding Fault Detection Methods in Resonant Grounding Distribution System: The problem of high resistance grounding fault detection in resonant grounding system is always the pain point and difficulty in the field of power system research. To solve the problem, based on PSCAD software, this paper firstly establishes a typical distribution system model, and analyzes the relationship between the transient component, traveling wave component and the fault initial angle, transition resistance value and arc. Secondly, this paper analyzes the effect of the main fault detection methods such as transient methods and travelling wave method, and gives the effective domain of different detection methods. Above analysis establishes a complete systematic test scheme for the high resistance grounding fault detection, and provides an effective test support for the subsequent effectual fault detection method for high resistance grounding fault.

D. Reichelt, Estimation of steady-state unbalanced system conditions combining conventional power flow and fault analysis software: In real three-phase power systems, their voltages and currents are not fully symmetrical. A method has been developed to estimate the effects of slight unbalanced network conditions for steady-state operation. A conventional power flow is followed by a linear incremental calculation using a three-phase model of the network. The unbalanced condition is handled like a multiple unbalanced fault. The process is illustrated for the case of a transformer bank with nonidentical single-phase units. The results show the effects of different transformer reactances and different voltage ratios, respectively.

Md. Mizanur Rahman, HVDC over HVAC power transmission system: Fault current analysis and effect comparison: `Fault current' is the flow of abnormal current through an improper path due to electric faults which causes enormous damages. In HVAC transmission system, Fault current due to electric faults is too large which affects the overall power system including-Receiving & Sending end bus, Transmission system, Load and even also the Power Generation Unit.

HVDC transmission system dramatically reduces these effects, as the fault current due to electric faults is much lower, and only affects the individual faulty section of the overall transmission system. In favor of HVDC system, this paper presents a `fault current' (due to asymmetric faults) analysis and comparisons between HVAC and HVDC transmission system. MATLAB (Simulink) simulation software is used to simulate both HVAC & HVDC power transmission system topologies. From the comparison of the simulation output-lower fault current, less fault effect, better performance & higher reliability is demonstrated for HVDC transmission system.

R.W. Wies, Use of ARMA block processing for estimating stationary low-frequency electromechanical modes of power systems: Accurate knowledge of low-frequency electromechanical modes in power systems gives vital information about the stability of the system. Current techniques for estimating electromechanical modes are computationally intensive and rely on complex system models. This research complements model based approaches and uses measurement-based techniques. This paper discusses the development of an ARMA (auto-regressive moving average) block processing technique to estimate these low-frequency electromechanical modes from measured ambient power system data without requiring a disturbance.

This technique is applied to simulated data containing a stationary low-frequency mode generated from a 19-machine test model. The frequency and damping factor of the estimated modes are compared with the actual modes for various block sizes. This technique is also applied to 35-minute blocks of actual ambient power system data before and after a disturbance and compared to results from Prony analysis on the ringdown from the disturbance.

Marko Čepina, Application of common cause analysis for assessment of reliability of power systems: The term common cause failure is related to a fact that several

components can fail or become unavailable due to a particular cause of failure and a coupling mechanism that creates the condition for multiple components to be affected by the same cause. The objective of this paper is to investigate the feasibility of common cause analysis to an electric power system, its applicability, the most appropriate method and the effects of the results to the reliability of the power system, where the static conditions are assumed.

The method for assessment of reliability of power systems is developed, which is based on the fault tree analysis and which integrates the common cause analysis. The results of example studies show that the method is suitable for reliability analysis of power systems and for improvement of power systems such as their upgrade in optimized manner and for optimization of their maintenance with minimizing the costs.

Sobhy S. Dessouky, DC Pole to Pole Short Circuit Fault Analysis in VSC-HVDC Transmission System: Voltage Source Converter High Voltage Direct Current (VSC-HVDC) transmission technology is widely used in electrical power transmission over very long distances. Those systems are subjected to different types of faults that have an effect on the electricity deliver continuity and reduce the device reliability. DC line faults are public in HVDC systems, it may occur in either overhead transmission lines or in submarine cables and with different configurations.

In such faults, the converter stations must be blocked to isolate the transmission line and to shield the electronic switches. Therefore, fault detection, isolation and system restoring techniques are very important to development the system reliability. In this paper, DC pole to pole short circuit fault has been carefully studied. The fault behavior has been discussed from the fault moment until the fault clearance. A Matlab-Simulink model has been built to verify the mathematical analysis.

A.N. Wang, Study of the Phase Shifting Effects of Transformer on Fault Analysis Model of Power System: In the conventional fault analysis and calculation method based on the symmetrical components, transformer is often expressed by a leakage reactance model, which ignores phase shifting effects. If the phase shifting effects consideration is needed, the common way is to modify the resulted positive and negative sequence components according to the phase shifting. This method now has been widely used in the traditional fault analysis field. This paper discusses the accuracy of this method.

By building two kinds of transformer models, one is the traditional which neglects the phase shifting effects, and the other is the model that considers the actual transformer winding connections (ATP model), the paper calculates the voltages and currents on the two sides of the transformer under various short- circuit faults at different locations. Comparing simulation results on both transformer models shows that there are different errors in voltages and currents under different fault types and fault locations as well. This paper seeks to point out problems with the conventional method, and proposes a potential solution to these problems.

Seungje Lee, Stability analysis of a power system with superconducting fault current limiter installed: As a process of developing high temperature superconducting fault current limiter (SFCL), the stability of a power system in which SFCLs were installed was analyzed. For the investigation into the effect of SFCLs to a power system, we have proposed a simple model power system that had SFCL circuits. The modeling parameters of SFCL are obtained by experiment of a prototype SFCL, which is 440 V class and a shielding type model.

This electric circuit was solved for transient performance by numerical methods. In case the SFCLs are installed in a power system, it can effectively protect synchronization both in a symmetrical three-phase fault and a single-phase line to ground fault by maintaining synchronism of the synchronous machines for a long time. By this analysis, we found a quantitative effect of SFCLs to a power system. Limiting fault currents means not only an improvement of circuit breaker abilities but also a protection of synchronism. So its synchronism protection property must be considered for a design of superconducting fault current limiters.

Guillermo Nicolau, Analysis of HV and MV Networks Faults Effect on Short Drops: This study-based paper describes the kind of short- circuits vs. the faulted networks that can produce short-drops in the voltage supplied to the Catalonia customers. Some experiences based on registered power-loss data during HV faults will be analyzed, along with the performance of the involved protective system (relays and breakers). An analytical method to calculate short-drops as a function of network short-circuit parameters is developed for MV radial networks. Finally, experience-based impacts for faults in HV systems and statistics of faults in the different HV faults in Catalonia are presented.

Takao Sato, Study on the Effect of Fault Current Limiter in Power System with Dispersed Generators: Dispersed generators are being introduced to power systems to secure the electric power supply. However, a short-circuit capacity of the power system increases with the introduction of dispersed generators.

As a result, there is concern that a fault current will increase further, and instantaneous voltage sag might be caused. It is proposed to apply a superconducting fault current limiter in the distribution system with dispersed generators to solve these issues. In this paper, the effect of

superconducting fault current limiter in this power system is studied by the analysis with EMTP and the confirmation test is conducted with a simulator.

Y. Shirai, Improvement of Power System Stability by Use of Superconducting Fault Current Limiter With ZnO Device and Resistor in Parallel: Superconducting fault current limiters (SCFCLs) are expected to improve the reliability and stability of power systems. SCFCLs can be classified into R-types (resistive) and L-types (inductive) by the fault current limiting impedance. An L-type FCL is more effective in suppressing the voltage drop during a fault. On the other hand, a R-type FCL is more effective in consuming the acceleration energy of generators at the fault.

Both functions lead to the improvement of the transient stability of the power system. We have proposed and fabricated the FCL unit, which is expected to have both functions. It consists of an inductive superconducting fault current limiter with a resistor and a ZnO device in parallel. In this paper, the simulation analysis on one machine and an infinite bus transmission system including the proposed FCL unit was carried out.

EMTP (electro-magnetic transients program) was used in order to analyze the power system characteristics of the FCL unit. A rotor angle of the generator and a critical fault clearing time were analyzed to evaluate the effects of the FCL unit on the improvement of the transient stability of the model power system. A contribution share of the voltage drop suppression and the acceleration energy consumption to the improvement of the power system stability were clarified with various conditions, such as, generator output and fault clearing time.

Mayur Basu, Effect of high penetrated reactive power support based Inverter-Based-Resources on the power stability of microgrid distribution system during faults: As the penetration level of inverter-based resources (IBRs) in a distribution system has been increasing, the development of the IBRs control scheme becomes mandatory, mainly to make the distribution systems more resilient to the disturbance. Most of the IBRs that have been integrated into the distributed systems operate in power factor correction mode. This control scheme focuses on optimizing their electricity production. Given this context, this control scheme might deteriorate the fault-ride through (FRT) capabilities during and after the fault. In a bigger picture, this might cause the system to collapse when the IBRs penetration is getting higher.

This paper proposes a novel control scheme of a photovoltaic (PV) power plant with enhanced FRT and fault restoration capabilities. To achieve this, the reactive current is injected into the system whenever it senses a fault. After the fault being cleared, the operation of control scheme changes to provide reactive power support to the system. The proposed method is verified using IEEE 13-bus system, which simulated using PSCAD simulator. The results show that the inclusion of the proposed scheme in a PV power plant would help the system to secure its resiliency for a severe network fault by supporting voltage stability during the fault and post fault condition.

Vasundhara Mahajan, Power System Stability Improvement with Flexible A.C. Transmission System (FACTs) Controller: Transient stability is important from the view point of maintaining system security that is the incidence of a fault should not lead to tripping of generating unit due to loss of synchronism and the possibility of a cascaded outage leading to system black out. TCSC allows the fundamental capacitive reactance to be smoothly controlled over a wide range. The TCSC controller can be designed to control the power flow, to increase the transfer limits or to improve the transient stability. The TCSC controller can provide a very fast action to increase the synchronization power through quick changing of the equivalent capacitive reactance to the full compensation in the first few cycles after a fault, hence subsequent oscillations are damped.

In the present work TCSC controller for single machine infinite bus (SMIB) and multi-machine power system is designed using SIMULINK (a software tool associated with MATLAB). Multi-machine power system with turbine and governing system is modeled. Modeling is done for system with TCSC controller. Effect of TCSC controller parameter variation on rotor angle is also studied. A detailed analysis is conducted for the proposed controller for different fault clearing time. It has been observed that TCSC controller can improve the stability margin significantly. TCSC controller provides variable impedance, which is required for the compensation. The presented controller is suitable only in capacitive zone. For the transition from a capacitive vernier mode to bypass mode the TCSC controller can be modeled with detailed dynamics.

Mei Zhang, An Aggregation Modeling Method of Large-scale Wind Farms in Power System Transient Stability Analysis: The operation states of wind turbines of large-scale wind farms are not identical due to the influence of voltage distribution and wake effect, etc.. So the accuracy of traditional single-machine dynamic aggregation model of wind farms is hard to meet the demand of security and stability analysis of power system with large-scale wind power integration. In order to improve the credibility of transient stability analysis of power systems. A simple fixed-scale clustering method of wind turbines was proposed, which takes “the sensitivity of the wind turbines affected by power systems fault” as the grouping index. Based on the clustering method, the aggregation modeling method of wind turbines and power collection system was proposed. In addition, the detailed model, multi-machine aggregation model and dual-

machine aggregation model were established by taking an actual grid-connected large-scale wind farm as an example. And the validity and reliability of the proposed aggregation modeling method of wind farms were verified by simulation analysis.

IV. CONCLUSION

In this paper the overview of different faults occurred in photovoltaic system are reviewed. The various strategies, models accessible in the literature section to assess the outputs which are generated intensity of PV cell are altogether looked into.

Distinctive summed up and customized programming projects are accessible for recreation of their models alongside MATLAB/SIMULINK. Alongside this, outline of various procedures/algorithms/strategies accessible for faultdiscovery and analysis for photovoltaic framework are concentrated in subtleties and in near way.

So as to build the adequacy, unwavering quality of a PV framework a solid fault finding strategy is must. The strategy ought to react to the fault in a brisk way with great precision and numerous calculations in writing tend to this concern. Online issue location is a zone which is as yet ignored. The speculation cost to build up an administrative and observing framework is still high, so it is extremely hard to suit little power plants into it. Single framework tends to a couple of shortcomings as it were. Basic faults, for example, faults because of Major delamination are not address yet.

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