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Protection of Utility Network with Solar Power Generation

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Abstract:

This paper designs a protection scheme method (PSM) for detection of faulty condition incident on the utility grid network with solar photovoltaic (PV) power generation. A fault index (FI) is designed by decomposing the current waveform by application of Hilbert transform (HT), Stockwell transform (ST), and Alienation coefficient (ACF) for detection of faulty conditions. An index for ground with fault (GFI) is also designed to identify ground involvement during faulty event. Fault classification is performed using faulty phase numbers and GFI. It is established that PSM effectively identified and categorized the fault events including fault on phase-A and ground (AGF), fault on phases-A& B (ABF), fault on phases-A& B and ground (ABGF), fault on all phases (ABCF) and fault on all phases with ground (ABCGF). Performance of PSM is better compared to ACF based PSM. Study is validated on IEEE-13 nodes test system interfaced with a solar PV system.

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I. Introduction

Power system protection has emerged as an important and most crucial problem for the network of power utilities due to penetration of high share of renewable energy (RE), wide application of flexible AC transmission system (FACTS), high voltage DC transmission system (HVDC), non-linear loads, switching events, and faulty events [1]. Solar energy penetration quantum to grid is continuously increasing in the network of utility grids. Converters of solar photo-voltaic (PV) systems and intermittent nature of solar generation affects the performance of protections scheme (PS) [2]. Signal processing methods such as Fourier transform (FT), Stockwell transform (ST), Hilbert Huang transform (HHT), and Wavelet transform (WT) are used for detection of fault events. The classification techniques used for categorization of fault events include Support Vector Machine (SVM), Artificial Neural Network (ANN), Fuzzy Logic (FL) system, Neuro-Fuzzy (NF) system, Genetic algorithm (GA), and Deep learning methods [3]. In [4], authors introduced a techniques for detection of power system faults in the presence of solar photo-voltaic (PV) system using discrete Wavelet transform (DWT). Performance of this technique is affected by the presence of noisy signals. A ST based method for identification of fault events pertaining with distribution network in the availability of solar energy is reported in [5]. A hybrid signal processing techniques for detection of fault events in the presence of solar PV generation is reported in [6].

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