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Using gold sequences to improve the performance of correlation based islanding detection

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ABSTRACT

One of the problems encountered when connecting distributed generators to a distribution system is the possibility of islanded operation. Traditionally this has been prevented through the application of passive under/over voltage and frequency relays which are triggered if the island contains mismatched amounts of active and/or reactive power, respectively. Various active techniques which reduce the power mismatch required for operation of the passive relays have been developed. These active techniques may fail to detect islanding in multiple generator islands if all the generators do not have identical active anti-islanding strategies. An islanding detection technique based on the correlation between disturbances in system voltage and a pseudo-random sequence used to perturb the generator's output was developed for use in islands where generators may have different anti-islanding strategies. Previous investigations have always used pseudo-random sequences from the maximal length family of sequences. It is demonstrated in this paper that using either a Gold or Kasami sequence instead of a maximal length sequence can improve the performance of the correlation technique.

1. Introduction

The potential for a number of different problems arises when distributed generators (DGs) are connected to a distribution system. One of these problems is the islanding condition. Islanding is the situation where a part of the system containing equal amounts of generation and load becomes isolated from the rest of the system and the DG(s) in the isolated portion continue to power the loads. This condition is generally undesirable because it risks damage to equipment from out of phase reclose attempts and, more importantly, may create a shock hazard for utility personnel [1]. Thus, it is standard practice to require DGs to detect the formation of an island and disconnect themselves from the system [2].

Often, the islanding condition can be detected passively through the use of over/under voltage (OV/UV) and over/under frequency (OF/UF) relays since a mismatch between the active or reactive power generated and consumed within the island will result in deviations in the island's voltage or frequency, respectively [1]. A number of active islanding detection methods have been developed to deal with the unlikely event of the OV/UV and OF/UF relays' failure to detect islanding. This can occur if the power generated and consumed in the island is matched. Many of the active methods are reviewed in [3]. These methods all rely on introducing some disturbance to the system which is held in check by the relatively strong utility source during normal (grid-connected) operation but triggers some positive feedback mechanism during an islanding event. This positive feedback of the disturbance eventually results in either the voltage or frequency deviating outside of acceptable limits and the islanding is then detected by the passive OV/UV or OF/UF relays. Many of the active methods have been shown to fail when there are multiple DGs connected within an island if they are not all equipped with identical active anti-islanding (AI) protection [4,5].

Some authors have proposed that in the future, islanding be allowed under certain circumstances as a means of increasing the reliability of service provided to customers [6–8]. Active islanding detection techniques are not suitable for use in such systems as they cannot detect islanding without causing the system to violate acceptable voltage or frequency operating limits.

An islanding detection method suitable for inverter interfaced DGs based on the correlation principle was first proposed in [9] and further investigated in [10,11]. This method operates by perturbing the output of a DG according to a predetermined pseudo-random, or pseudo-noise (PN), sequence and observing the correlation between the PN sequence and disturbances in system voltage. The correlation technique was shown by [4,5] to have superior performance to many active methods in multi-DG islands. Furthermore, the correlation AI technique is capable of detecting islanding without forcing the system to violate operating limits.

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