Background

Islanding occurs when part of the distribution system becomes electrically isolated from the grid with the local DG energizing the isolated area. The capability of anti-islanding protection is a very important requirement for distributed generators (DG). A power line signaling based scheme for anti-islanding protection has been proposed in a companion paper. In the scheme, a signal generated by power electronics is injected from a central upstream location to the DG sites. The lack of a signal at the DG site indicates that the DG is islanded.

Signal Generation

The principle of the waveform distortion technique is illustrated in Fig. 4. The thyristor between phase A and ground is designed to fire at a certain angle ahead of the zero-crossing point in the negative-going voltage, creating a momentary short circuit. The thyristor naturally turns off when its current becomes zero. This small distortion around the zero-crossing point is the signal.

Signal Detection and Extraction

The voltage distortion exists in only one of four cycles and the signal is extracted by subtracting two consecutive voltage cycles. Therefore, it contains two segments in each signaling period, one has the signal and the other doesn’t. The method of subtraction can remove background noises in the regular waveform leaving only the signal.

Anti-Islanding Protection of DG Field Test with Manitoba Hydro

The signal generator (SG) was connected to the 12kV bus through a three-phase 300kVA 12kV/600V step down transformer at the test site. A data acquisition unit was also installed for monitoring the status of the SG. The signal detector (SD) implemented on a Labview-based real-time data acquisition unit is located in the main building, which is about 500m away from the SG.

Conclusions

• The proposed anti-islanding scheme was successful during the test. No nuisance trip events were recorded due to higher signal strength and the better performance of the new detection algorithms.

• The strength of the signal is affected by the firing angle. A large firing angle is better for signal detection. However, to avoid interference with the normal operation of the power system, the firing angle cannot be very large. 25 degrees and 30 degrees are acceptable. Theoretically, it can reach up to 40 degree, where the signal strength is 5% of the rated voltage.

• Signal strength varied with the loads in the test area. The strength of signal dips in daytime and rises at night in a single day and it does not vary as much in weekend as that of the weekday, because some large loads only run during the working time of a weekday.

• Frequency drift is proven to be a major contributor to warning events, as it leaves a large amount of fundamental component in the signal and non-signal segments. This problem can be solved by removing the fundamental component before the calculation.

• Both of the detection algorithms, RMSH and RMSI, have good performances in the test. RMSH has a better performance than RMSI, as the latter highly relies on the accuracy of the template and the signal to noise ratio is lower.

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