Islanding Detection for Distributed Generation

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Introduction

Islanding detection is important for protecting personnel, preventing equipment damage, and providing good power quality in power systems with distributed generation (DG). This application note discusses islanding detection systems based on wide-area, time-synchronized measurements.

Figure 1 shows a typical network configuration for DG in which opening any of the breakers (B1 through B5) results in an islanding condition. During an islanding condition, ac machines are vulnerable to out-of-phase closing, which can cause permanent damage to ac machines. Failure to trip islanded generators can pose safety risks for utility personnel and can also lead to power quality concerns with the connected loads. For these reasons, utilities require islanded distributed generators to be disconnected as fast as possible to minimize hazardous operating conditions.

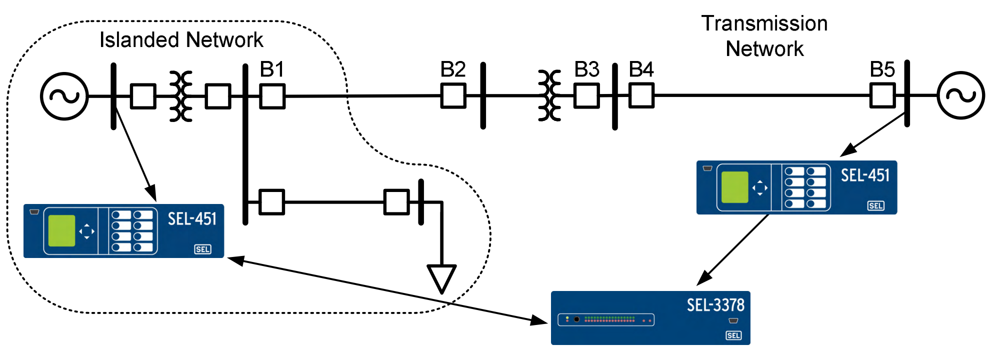

Figure 1 Wide-area islanding detection system for typical distributed generation applications

Islanding Detection System With Time-Synchronized Measurements

Islanding detection methods that use only local measurements cannot detect islanding conditions if the power (real and reactive) mismatch between the DG and the local load is negligible. Systems that use time-synchronized measurements can detect islanding during all power exchange conditions. Figure 1 shows a system with one SEL-451 Relay at the DG site and another SEL-451 at a transmission substation. Both relays acquire voltage phasor measurements from their corresponding sites. These relays send synchrophasor messages to the SEL-3378 Synchrophasor Vector Processor (SVP) at specific time intervals (60 messages per second, for example). The SVP uses the positive-sequence voltage synchrophasors that relays acquire to calculate the angle difference (δ) between these voltages. The change of δ with respect to time defines the slip frequency (S_f), and the change of S_f with respect to time defines the acceleration (A_f) between the two areas. This SEL wide-area system uses the angle difference and slip-acceleration methods for islanding detection.

Angle Difference Method

The SVP compares δ against an angle threshold (20 degrees, for example). If δ is greater than the threshold for longer than a predefined time, the logic declares an islanding condition.

Slip-Acceleration Method

Figure 2 shows the normal operating condition and islanding operating condition regions of the special characteristic based on S_f and A_f. The characteristic monitors how the two systems are slipping against each other as well as how fast the systems are slipping. Based on the operating point in the characteristic, the element declares an existing islanding condition.

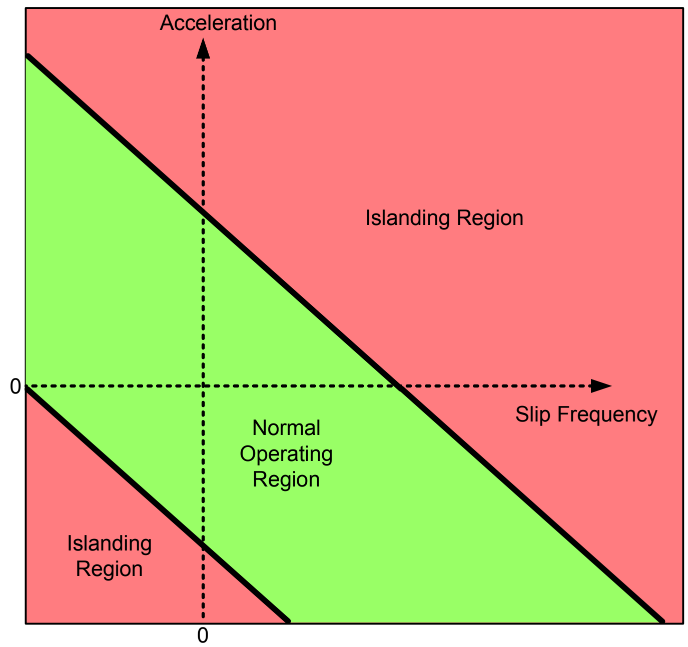

Figure 2 Normal operating condition and islanding operating condition regions of the wide-area islanding detection characteristic

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