Application Note AN2009-59

Islanding Detection and Adaptive Load Shedding

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INTRODUCTION

Interconnections are conventionally established to provide reliable power to customers. When local system islanding occurs, the proposed scheme initiates the load-shedding process based on the intertie power exchange and the amount of local power generation to maintain power system stability. Figure 1 shows a local system connected to two external systems via Intertie 1 and Intertie 2.

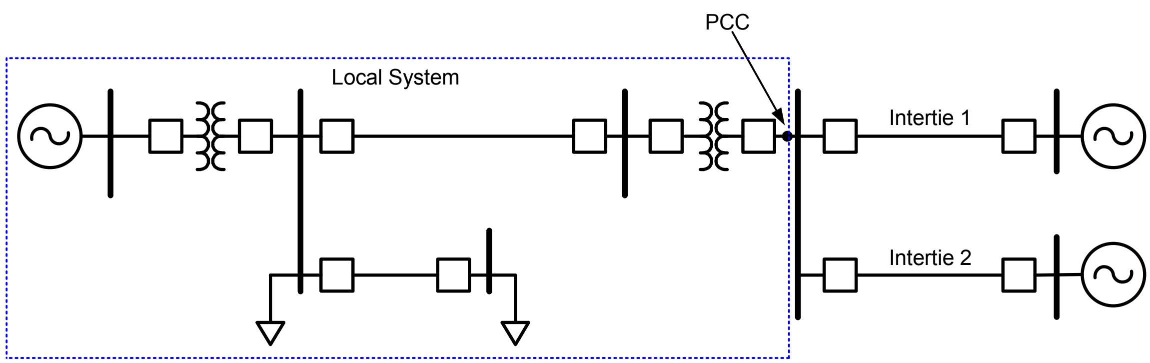

Figure 1 Intertie 1 and Intertie 2 Provide Power Support Based on the Local System Requirements

Traditionally, the islanding condition is detected by monitoring the intertie breaker at the PCC (point of common coupling). Additionally, protective relays monitor frequency and voltage magnitude to detect this condition. The adaptive load-shedding algorithm uses power exchange data, reserve margins available at the local generation, and the shedding priority of the loads as inputs. This application note discusses how to detect the islanding condition and activate the load-shedding process to maintain system stability during the islanding condition.

SEL SOLUTION

Islanding Detection

SEL proposes two islanding detection methods. The first one is based on local measurements, and the second one uses wide-area, time-synchronized measurements. Method 1 uses frequency and dfdt (rate of change of frequency) to provide secure and fast islanding detection. In Method 2, the wide-area-based detection complements the local-based detection for the condition where the power exchange is minimal. The wide-area-based scheme calculates the slip frequency and acceleration between the two systems to detect the islanding condition (see AN2009-55, “Islanding Detection for Distributed Generation,” available at http://www.selinc.com). The power exchange between the local system and the utility affects the response time of both methods.

Adaptive Load Shedding

To optimize power delivery, it is ideal to trip only the load necessary for the system to maintain system stability. To achieve this goal, the adaptive load-shedding scheme calculates the amount of power that must be shed (P_{SD}) in real time according to the following equation.

$$P_{SD} = \sum_{n=1}^{k} P_T - \sum_{n=1}^{m} (P_{GMax} - P_G)$$

where:

P_T is the real power from the intertie connections.

k is the number of intertie connections.

P_{GMax}–P_G is the MW reserve in each local generator.

m is the number of local generators.

The load-shedding processor initiates the load-shedding actions based on P_{SD} and load priorities. In order to further optimize load shedding, add underfrequency supervision to the scheme.

Islanding Detection and Load-Shedding System

Figure 2 shows four SEL-451 Protection, Automation, and Control Systems for power flow monitoring. Relay 1 and Relay 2 monitor the local generation and intertie power flow, respectively. Relay 3 and Relay 4 monitor power consumption. The relays send time-synchronized phasor data to the SEL-3378 Synchrophasor Vector Processor (SVP). Islanding detection and adaptive load-shedding logic are implemented in the SVP. Based on load priority and P_{SD}, the SVP sends commands to Relay 3 and Relay 4 to open the load breakers.

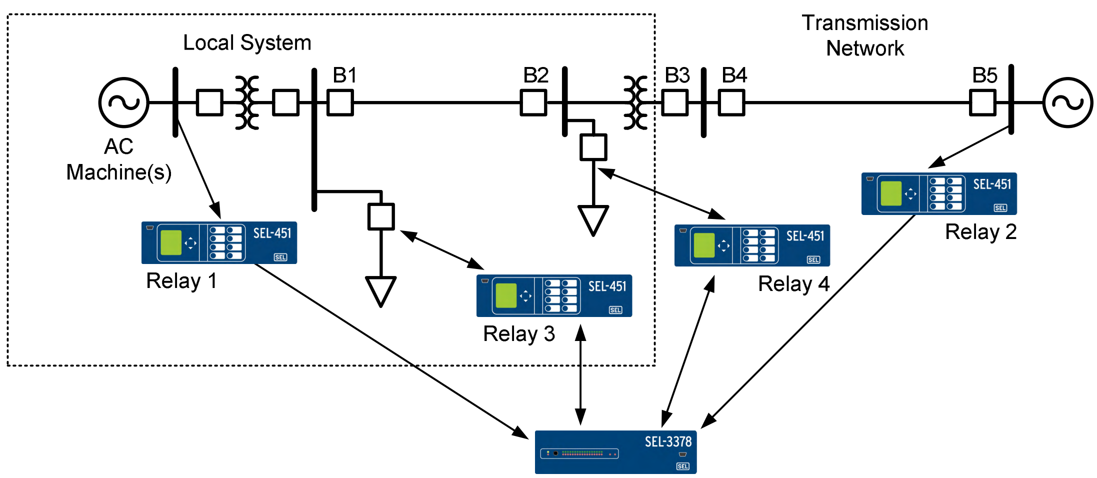

Figure 2 Islanding Detection and Load-Shedding System

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