Anti - islanding Tech Brief

What is islanding?

Islanding is a condition in which a distributed energy resource (DER) continues to energize a portion of the power system when it is electrically isolated from the utility grid. Intentional islanding in which the island is planned, properly protected, controlled, and coordinated with the local electric power system, can offer resilience during grid outages. However, unintentional islands do not have these properties, they could become harmful to connected equipment because the DER might not be designed to maintain frequency and voltage without a utility source, thereby leading to abnormal frequencies and voltages. Not only that, the unintentional island could present a hazard to utility workers or other people in the area who may not realize that a circuit is still powered.

For those reasons, a DER must detect islanding and immediately disconnect from the grid circuit. Specifically, according to IEEE 1547-2018, if an unintentional island is formed by the DER, the DER must detect the island and disconnect from the distribution grid within 2 seconds of the island formation.

Islanding detection methods

The common detection methods of anti-island effect are passive island detection and active island detection.

Passive detection method, such as Over/Under Frequency (OUF), Over/Under Voltage (OUV), Phase Jump Detection (PJD), and Harmonic Detection (HD), have the advantages of simple principle, easy realization and no effect on power quality.

However, the non-detection zone is large when a passive isolated island detection method is used alone. To overcome shortcoming that Passive methods has the large NDZ, Active islanding detection methods should be adopted by a DER.

Active islanding detection methods add small perturbations to the inverter output current so that islanding conditions may be detected in a faster way and decrease the non detection zone (NDZ) of the passive methods. Common methods of active anti-islanding detection noted in literature include:

- Impedance measurement
- Impedance detection at a specific frequency
- Slip-mode frequency shift
- Sandia frequency shift
- Sandia voltage shift
- Frequency jump
- Mains monitoring units with allocated all-pole switching devices connected in series

Sandia Frequency Shift

Sandia Frequency Shift (SFS) is one of the active islanding detection methods that depend on frequency drift to detect an islanding condition. These methods depend on injecting a distorted current waveform into the original reference current of the inverter, therefore, in case of islanding operation, the frequency drift up or down depending on the sign of the so called chopping factor “Cf”. A positive feedback is utilized to prevent islanding and to decrease NDZ value. The procedures of applying the SFS method can be summarized as follows :

1. Inject a current harmonic signal with a limited duration into the Point of Common Coupling (PCC) so as to comply with the maximum THDi allowed by interconnection standards.
2. The injected current signal distorts the inverter current by presenting a 0 A segment for drift up operation as shown in Fig. 1.

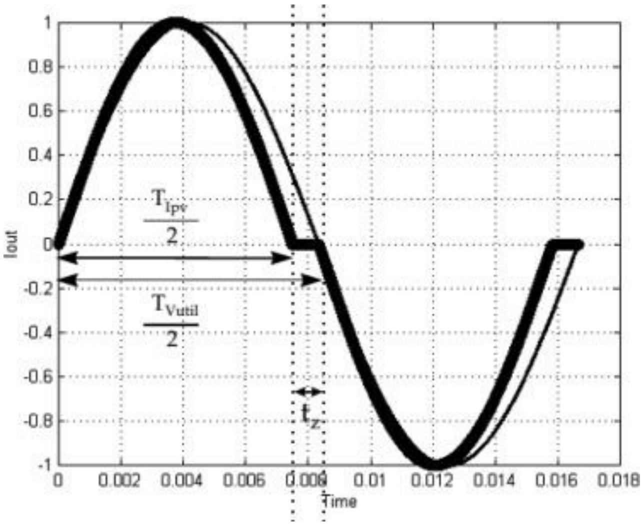

Fig. 1 AFD current reference of inverter.

3. The desirable effect of the 0 A segment, is that the fundamental component of the inverter current leads the voltage by a small angle θ_{AFD}, which is frequency dependent and it creates a positive feedback.
4. When the grid is disconnected, the frequency of the voltage of the PCC tends to drift, reaching values higher until the frequency is out of the OFP/UFP trip window (Range) and the inverter is disconnected.
5. A positive feedback is utilized to prevent islanding.

How does FranklinWH do it?

Franklin Home Power (FHP) system includes a smart transfer switch, referred to aGate, which contains a microgrid interconnect device (MID) that allows disconnecting from the local EPS to form an intentional island. In addition, it contains DER relays to disconnect and reconnect your system from the utility grid when there is a fault condition, which is accomplished with anti-islanding technology to prevent the formation of un-intentional islands.

FHP system has Over/Under Frequency (OUF), and Over/Under Voltage (OUV) protections. The trip threshold could be set according to the local interconnection standards, such as California Rule21 or Hawaii Rule14H, etc.

As a supplement, FranklinWH utilizes **<u>Frequency Shift with continuous positive frequency feedback</u>**, as referred to Sandia Frequency Shift (SFS), to detect the islanding conditions faster and decrease the NDZ of the passive methods. Introducing small perturbations to the PCC, which cause an increase to the frequency compared to the previous cycle. In case a fault occurs to the grid, PCC frequency will increase until it reaches the threshold and trips FHP OUF protections, resulting in a disconnect from the grid, with the process taking less than 2 seconds.