SG110CX

Islanding Protection

SUNGROW

Version 1.0 EN

1. Introduction

This document describes the islanding detection and protection(also called anti-islanding) function of the PV inverter SG110CX.

2. Anti-islanding

Islanding refers to the phenomenon that the load and part of the power grid continue to operate in isolation after disconnection from the main grid. Islanding may be either planned or unplanned. Standard requirements for protection against islanding target at the protection of unplanned islanding.

According to the IEC 61727 standard and IEEE1547, all grid-connected inverters must possess an effective anti-islanding function (they shall be configured with at least one active and one passive effective anti-islanding protection method). At the same time, this standard stipulates that the effective anti-islanding protection for grid-connected inverters should actively shut down the PV inverter within 2 seconds of disconnection from the grid.

2.1. Islanding Detection Principles

There are two common types of islanding detection methods: passive detection and active detection.

The passive detections is achieved by detecting the changes to the grid parameters that occur during islanding. Typical passive detections include: over/under-frequency and over/under-voltage detection methods, phase angle jump detection methods, and harmonic detection methods.

The basic principle underlying active detection methods is that, when the inverter introduces small perturbations, a certain grid parameter (frequency, phase, harmonics, active/reactive power) will experience small changes. When the parameter change exceeds a certain threshold, islanding protection will be activated. the typical active detections include: frequency drift method, grid impedance estimation algorithm, and islanding detection method based on phase-locked loops.

2.2. SG110CX Anti-islanding Solution

Based on the requirements of the related standards, the islanding detection function for the SG110CX inverter uses a combined passive and active detection method.

Passive Islanding Detection

The inverter measures the voltage and frequency at a common point and triggers the protection function when the measured values exceed the over/under-voltage or over/under-frequency thresholds.

This method has detection blind spots. That is, when the local grid's load power matches or nearly matches the grid-connected inverter's output power, the changes to the voltage and frequency at the load-side will be very small, so the passive detection method may be ineffective. However, the likelihood of such a situation is very low.

When the grid load and inverter output nearly match, the changes to the voltage and frequency on the load-side will be very small. In such situations, the passive islanding detection method may be ineffective. In consideration of such situations, the inverter also has an active islanding detection method.

Active Islanding Detection

The inverter's active islanding detection does not directly perturb the frequency. Instead, by controlling the reactive current, it indirectly offsets the grid frequency, without interfering with the current waveform. This reduces the negative effects on THD.

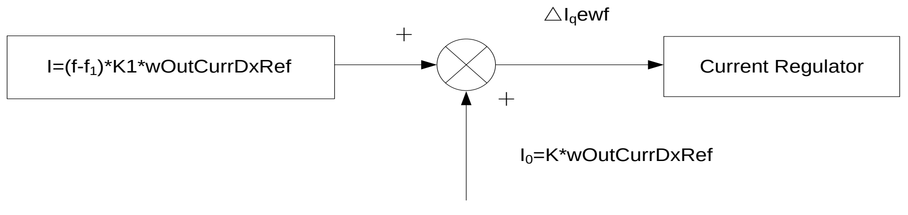

Fig.1. Current Perturbation Components

The reference reactive current of inverter consists of two components: The I_0, which is related to the size of the active current, will excite a change in the grid frequency during islanding; the I, which is related to the frequency offset, forms a positive feedback loop for frequency changes.

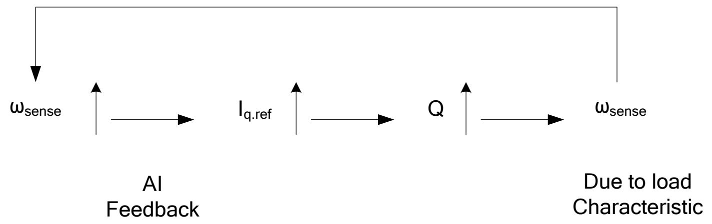

Fig.2. Positive Frequency Feedback

After the inverter is connected to the grid, it continuously inputs a small reactive current to the grid. When islanding does not occur, the frequency (f) detected at the PCC does not experience significant changes. When islanding occurs, because a significant frequency change is detected at the PCC, the inverter will issue a different reactive current value (I). If an increase in the voltage and frequency is detected at the PCC, Δiq will increase, i.e. the inverter's reactive output will increase. Based on the load characteristics, this will induce a further increase in the voltage and frequency at the PCC, forming a positive feedback loop until the over-frequency protection is triggered. Likewise, if the initially measured frequency decreases, it will trigger low-frequency protection.

Here, the reactive current output by the inverter is not determined by the current frequency and fundamental frequency offset. it is determined by the difference between the current frequency and the previous cycle frequency. This ensures that, when the actual grid frequency is not the rated frequency, the reactive current actively sent to the grid by the inverter will remain very low.

3. Compatibility of Anti-Islanding and LVRT

The anti-islanding function is compatible with LVRT function (low voltage ride through).

Different countries may follow different grid codes, e.g. BDEW grid code for Germany, UL1741 SA for US, etc, in which LVRT requirements may differ; the description below gives an example for how the anti-islanding is compatible with LVRT required by German BDEW grid code.

According to the BDEWMV grid code, the inverter must stay connected with the grid in the event of voltage drops to less than 90 % Uc (rated grid voltage) for a certain duration, i.e. LVRT.

During the LVRT, because the grid exists and the grid capacity is large, the active islanding detection can't induce grid frequency and voltage changes. Therefore the anti-islanding algorithm will not erroneously activate protection.

When the grid is lost, the inverter and load, a self-powered islanding system, active perturbance will cause changes to the island grid frequency and amplitude parameters until the relevant protection conditions are met. Then, the inverter's control unit will perform certain logical operations to determine that it is in the islanding state and consequently implement anti-islanding protection. This logic is shown in the diagram below:

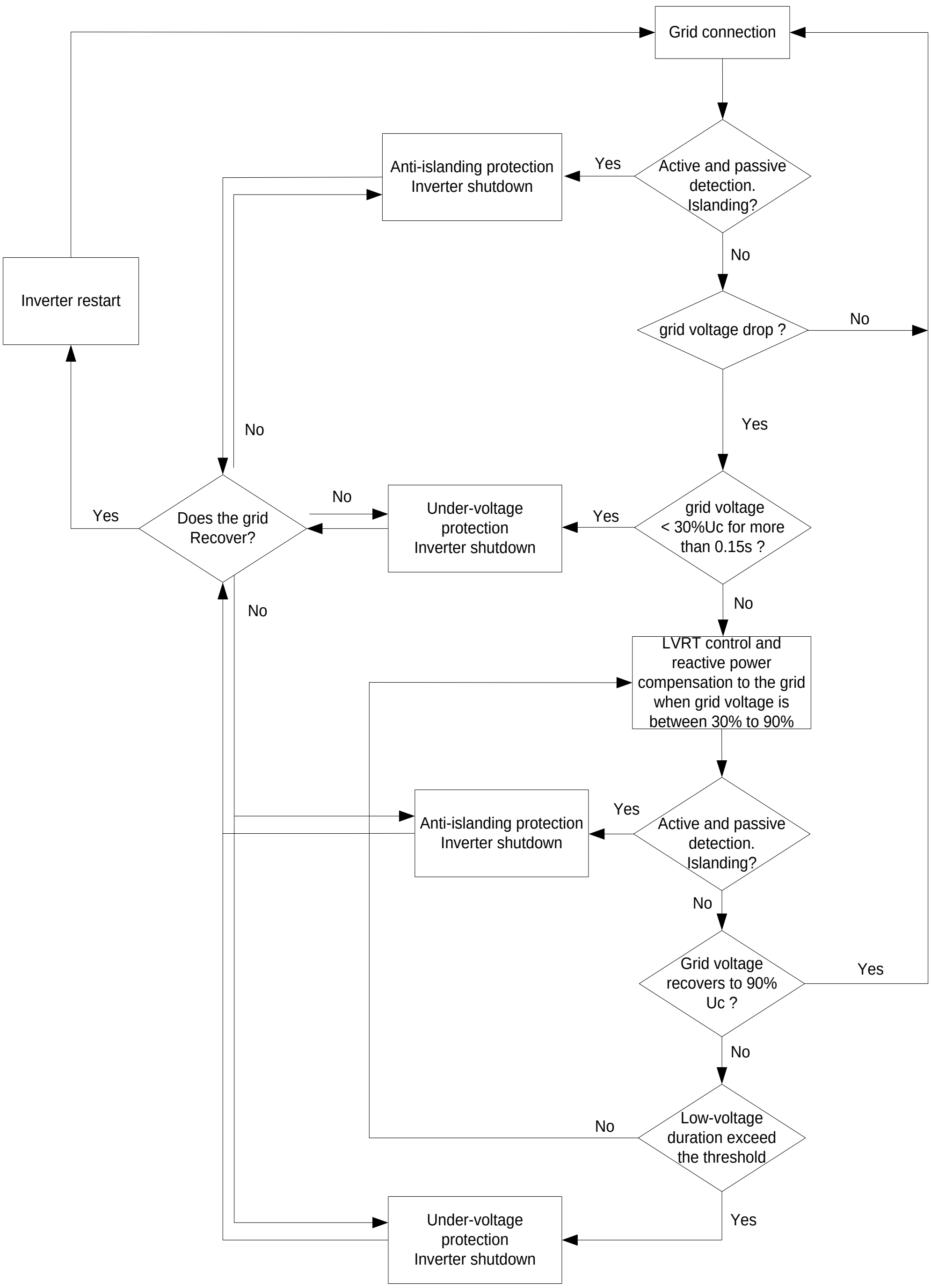

Fig.3. Islanding Protection Logic Flowchart