SolarTech Power Solutions

Photovoltaic inverter low frequency oscillation

Overview

The low-frequency oscillation (LFO) problem of photovoltaic (PV) grid-connected systems has been a critical concern for safe operation, whereas the impact of dc-side components of PV plants are always ignore.

What is low-frequency oscillation (LFO)?

However, low-frequency oscillation (LFO) is introduced as a side effect owing to the simulated swing equations in the VSGs. Although LFO has been widely researched in synchronous generator-dominated power systems, the mechanisms and mitigation strategies of VSG-related LFO have been found to be quite distinct.

Is low-frequency oscillation a side effect of VSG-related LFO?

Future research trends for the VSG-related LFO are presented. Virtual synchronous generators (VSGs) are effective solutions for low-inertia issues caused by the high penetration of inverter-based resources. However, low-frequency oscillation (LFO) is introduced as a side effect owing to the simulated swing equations in the VSGs.

What is VSG-related low-frequency oscillation?

Various mechanisms of virtual synchronous generator (VSG)-related low-frequency oscillation (LFO) are classified and compared with the traditional synchronous generator-related LFO. Modeling, analysis methods and suppression strategies for the VSG-related LFO are reviewed and compared. Future research trends for the VSG-related LFO are presented.

Does low-frequency oscillation damage a VSG?

However, low-frequency oscillation (LFO) is introduced as a side effect owing to the second-order oscillation characteristics of the VSG. If not properly damped, the oscillation may damage the VSG because of its low overcurrent capability; thus, this issue has attracted considerable attention from both academia and industry.

Are virtual synchronous generators effective solutions for low-inertia issues?

Modeling, analysis methods and suppression strategies for the VSG-related LFO are reviewed and compared. Future research trends for the VSG-related LFO are presented. Virtual synchronous generators (VSGs) are effective solutions for low-inertia issues caused by the high penetration of inverter-based resources.

What is the frequency of VSG-related LFO?

Table 2 summarizes the frequency and causes of VSG-related LFO reported in the existing literature. Compared with the typical frequency range of SG-related LFO (0.1 Hz–2 Hz [32, 103]), the oscillation frequency of VSG is relatively higher, between 0.1 and 10 Hz.

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Oscillation analysis of low-voltage distribution systems with high

Nov 26, 2020 · The analysis of complicated system oscillations using a time-frequency behavior provide useful information on the slow and fast evolution of system dynamics. In this paper, an ...

Ultra-Low Frequency Oscillation Damping Control Method ...

Sep 12, 2024 · In recent years, ultra-low frequency oscillations (ULFOs) have occurred in power systems with a high proportion of hydropower, which seriously threatens the system stability. ...

Low-frequency oscillation analysis of two-stage ...

The low-frequency oscillation (LFO) problem of photovoltaic (PV) grid-connected systems has been a critical concern for safe operation, whereas the

impact of dc-side components of PV ...

Harmonics and Noise in Photovoltaic (PV) Inverter and ...

Aug 1, 2022 · 1. Introduction PV inverters use semiconductor devices to transform the DC power into controlled AC power by using Pulse Width Modulation (PWM) switching. PWM switching is ...

Bang-Bang control of active and reactive powers in photovoltaic ...

Feb 1, 2023 · A novel control strategy of photovoltaic-battery system for restraining the photovoltaic power fluctuations and suppressing the low frequency oscillations of power system

Harmonic characteristics and control strategies of

grid ...

Nov 1, 2022 · From the three-phase voltage waveform of the grid-connected bus in Fig. 20 (a), it can be seen that before t = 1.5 s, the PV inverter adopts the harmonic mitigation control ...

Low-frequency oscillation analysis of two-stage ...

frequency oscillations in real grid-connected PV plants have been reported in [1]. Meanwhile, a 7 Hz osc llation was observed in a utility-scale plant during transmission line outage [2]. The low ...

Impedance characteristics investigation and oscillation ...

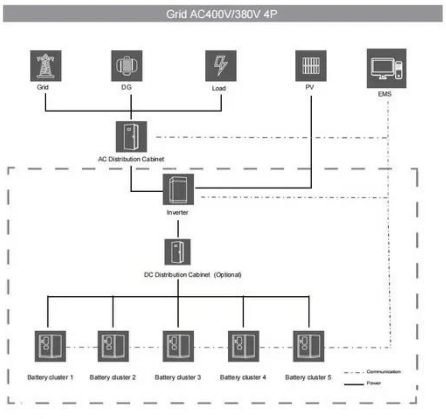
It is demonstrated that the increase of the PLL bandwidth and the decrease of the integral gain of the outer voltage loop will both lead to the oscillation of the PV inverter. Moreover, the ...

Grid-connected PV inverter system control optimization ...

Aug 7, 2025 · By embedding intelligent metaheuristic optimization into a classical PID framework, this work advances the state of inverter control strategies for PV systems.

Impedance characteristics investigation and oscillation ...

Aug 1, 2022 · It is demonstrated that the increase of the PLL bandwidth and the decrease of the integral gain of the outer voltage loop will both lead to the oscillation of the PV inverter. ...



Reduced-Order Analytical Model of Grid-Connected ...

Dec 23, 2020 · o state-space models are proposed to repre-sent a grid-connected PV system for low-frequency oscillation analysis. The two models implify the dc side of the PV system with ...

Two-stage PV grid-connected control strategy based on ...

Nov 30, 2023 · A DC-link voltage control and AC side reactive power control strategy for converter that can effectively suppress low-frequency grid oscillations in offshore wind power was ...

Low-Frequency Oscillations and Resonance Analysis of VSG ...

Oct 24, 2024 · For permanent magnet synchronous generator (PMSG) based wind generation systems connected to power grid via VSG-controlled grid-forming inverters, some novel ...

Innovative adaptive virtual impedance for resonance frequency

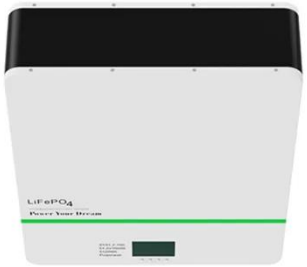
Feb 1, 2025 · Microgrid architectures are typically composed of multiple parallel grid-connected inverters, interconnected via LCL filters to comply with grid code requirements while offering ...

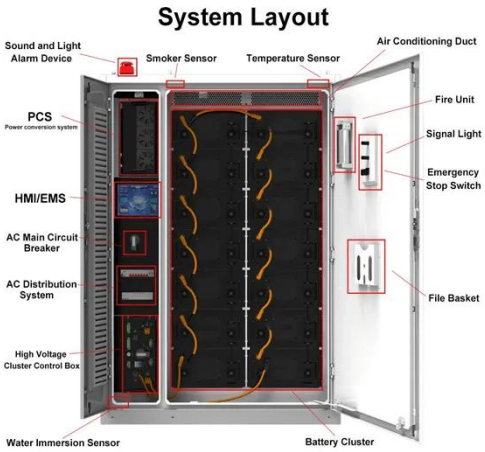
Low-frequency oscillation damping strategy for ...

Dec 7, 2024 · This paper constructs the Phillips-Heffron model of the VSG grid-connected system and analyses the mechanism of low-frequency oscillation in ...

Low-frequency oscillation analysis of two-stage photovoltaic ...

Nov 1, 2022 · The low-frequency oscillation (LFO) problem of photovoltaic (PV) grid-connected systems has been a critical concern for safe operation, whereas the impact of dc-side ...





Coordinated control strategy for low frequency oscillations ...

May 11, 2023 · Simulation results show that the proposed method can effectively suppress the low frequency oscillation and increase the system's capability ofsending power in a certain extent.

Photovoltaic inverter low

frequency oscillation

What causes a low-frequency oscillation in an inverter? However, most challenging oscillations are low-frequency oscillations induced by coupling interaction between the outer loop ...

An Improved FCS-MPC Strategy for Low-Frequency Oscillation

Mar 20, 2023 · With the rapid promotion of photovoltaic (PV) power generation, the local consumption of distributed PV power generation at medium and low voltage levels widely ...

New Control Strategy Based PV

Jul 5, 2023 · In long transmission lines, one of the major hindrance for transferring power is, power oscillation (0.1 HZ to 2 Hz) [1-2]. These low frequency oscillations due to electrical and ...

Hybrid synchronization based grid forming control

for photovoltaic

Jun 1, 2024 · In this paper, the hybrid synchronization based grid forming (HS-GFM) control and coordination strategy are proposed for the inverter and boost converter to provide frequency ...

Damping LFOs: Grid Following with Power Oscillation ...

May 30, 2025 · Abstract Low-frequency oscillations (LFOs) present a significant challenge to the stability and reliability of power systems, especially in grids with a high penetration of ...

Effective damping of local low frequency oscillations in power systems

Dec 16, 2021 · High penetration of renewable sources into conventional power systems results in reduction of system inertia and noticeable low-frequency oscillations (LFOs) in the rotor speed ...

Small-Signal Model and

Stability Control for Grid ...

Jun 29, 2021 · This paper presents a small signal stability analysis to assess the stability issues facing PV (photovoltaic) inverters connected to a weak grid. It ...

Analysis and suppression of low-frequency oscillation of photovoltaic

May 14, 2023 · The influence of various leading factors on low-frequency oscillation modes of photovoltaic power generation is analyzed. Finally, a low-frequency oscillation stabilizer ...

Reduced-Order Analytical Models of Grid-Connected ...

Abstract--Low-frequency oscillations have been observed in a real-world solar photovoltaic (PV) farm. The goal of this research is to build a simplified analytical model in the synchronous ...

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