Internal Model–Based Zero-Level Control of an Inverter-Based Microgrid

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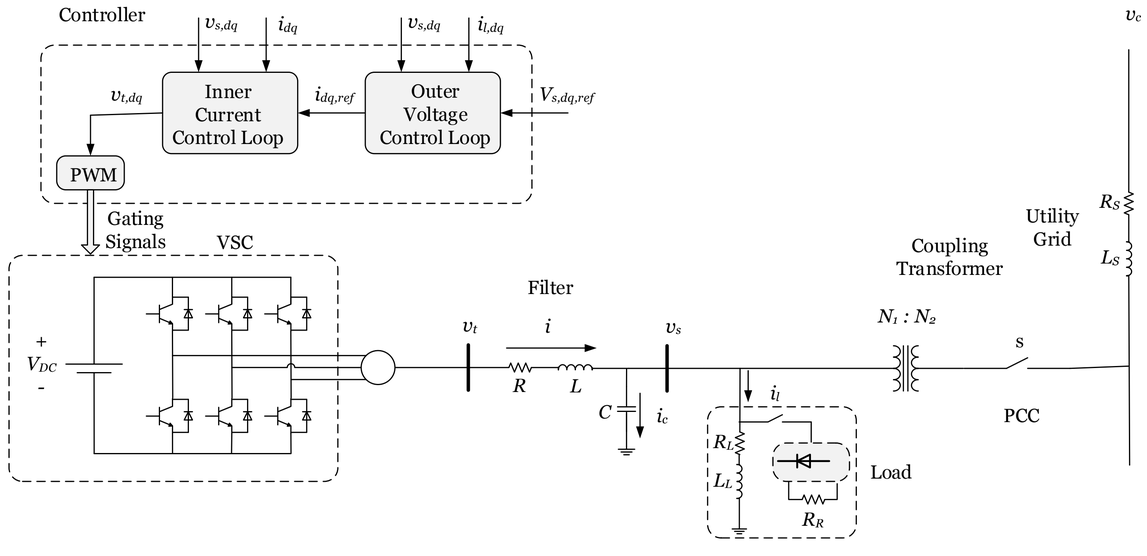
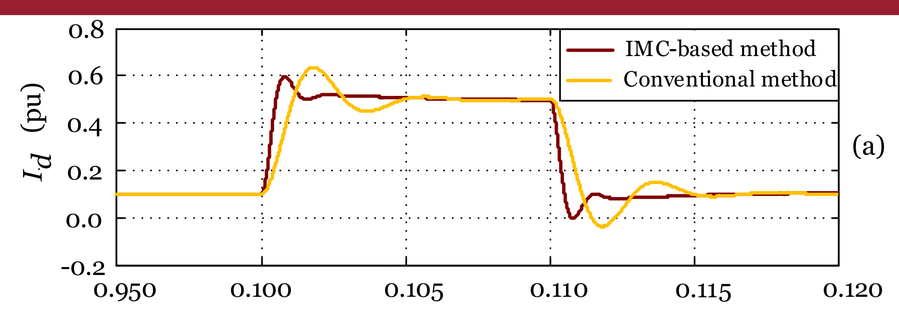
Introduction

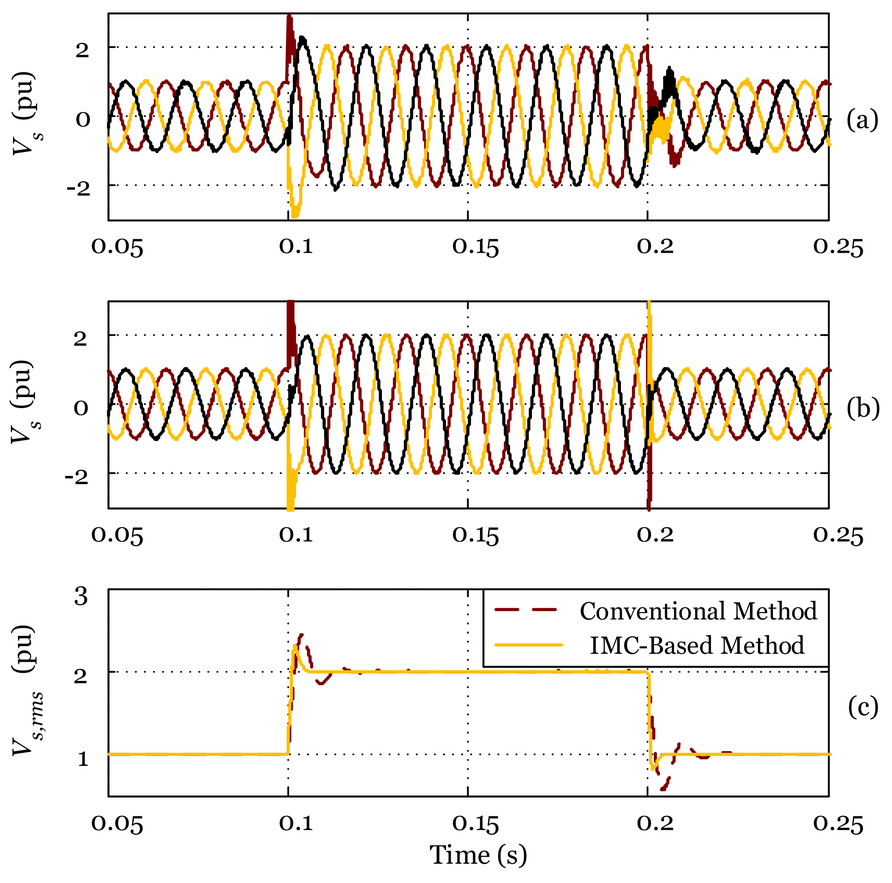
- VSCs can operate in two modes: current-sourced inverter (CSI) and voltage-sourced inverter (VSI).
  - A DG unit operates in the CSI mode when the microgrid is in the grid connected mode to supply preset values of real and reactive power.
  - A DG unit operates in the VSI mode when the microgrid is in the islanded mode to maintain the nominal voltage and frequency of the system.
- The use of PI-based controllers in the zero-level control dominates the control practice in inverter-based microgrids.
- The proposed IMC-based approach has superior transient performance and is more robust against system parameter uncertainties.



Simulation Results



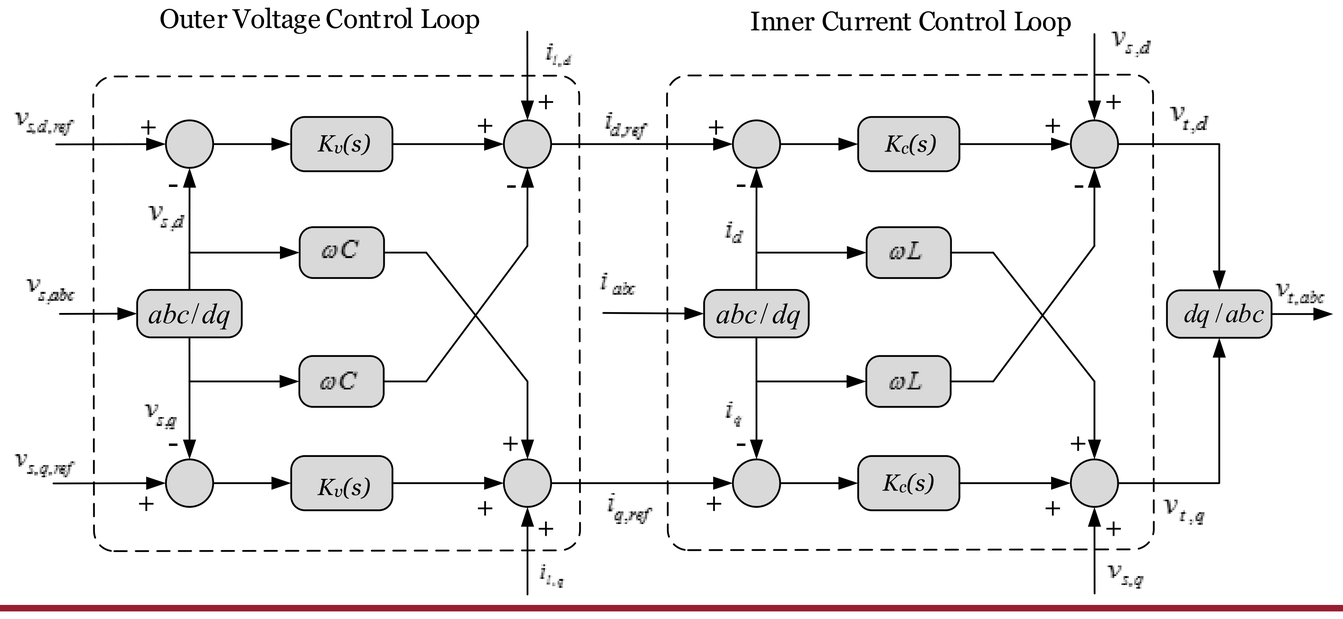
Dynamic response of the direct and quadrature component of output current of the DG unit in grid connected mode.



Dynamic response of the output voltage of the DG unit in islanded mode.

Proposed Controller

$$\begin{cases} k_p = \dfrac{RT_{\mathrm{PWM}} + L}{\lambda} \\ k_i = \dfrac{R - T_{\mathrm{PWM}}L\omega^2}{\lambda} \\ k_d = \dfrac{T_{\mathrm{PWM}}L}{\lambda} \end{cases} \quad \begin{cases} k'_p = \dfrac{2\omega L T_{\mathrm{PWM}}}{\lambda} \\ k'_i = \dfrac{\omega(L + RT_{\mathrm{PWM}})}{\lambda} \end{cases} \quad \begin{cases} k_p = \dfrac{C}{\lambda} \\ k_d = \dfrac{CT_c}{\lambda} \end{cases} \quad \begin{cases} k'_p = \dfrac{C\omega T_c}{\lambda} \\ k'_i = \dfrac{C\omega}{\lambda}. \end{cases}$$



- The salient features of the proposed cascade voltage controller compared with the conventional PI-based controller are that the proposed method has
  - Less overshoot;
  - Shorter settling time;
  - Significantly faster step response;
  - Higher robustness against system uncertainties;
  - Higher robustness against load variations; and
  - Better performance under unbalanced and nonlinear load.