DESIGN OF TRANSFORMERLESS THREE-PHASE GRID-CONNECTED PHOTOVOLTAIC INVERTERS

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ABSTRACT

The dc component is a special issue in transformerless grid-connected photovoltaic (PV) inverter systems and may cause problems regarding system operation and safety. IEEE standard 1547-2003 has defined the limit for dc component in the grid-side ac currents, e.g., below 0.5% of the rated current. The dc component can cause line-frequency power ripple, dc-link voltage ripple, and a further second-order harmonic in the ac current. This paper has proposed an effective solution to minimize the dc component in three-phase ac currents and developed a software-based approach to mimic the blocking capacitors used for the dc component minimization, the so-called virtual capacitor. The "virtual capacitor" is achieved by adding an integral of the dc component in the current feedback path. A method for accurate extraction of the dc component based on double time integral, as a key to achieve the control, has been devised and approved effective even under grid-frequency variation and harmonic conditions. A proportional integral- resonant controller is further designed to regulate the dc and line-frequency component in the current loop to provide precise control of the dc current. The proposed method has been validated on a 10-kVA experimental prototype, where the dc current has been effectively attenuated to be within 0.5% of the rated current. The total harmonic distortion and the second-order harmonic have also been reduced as well as the dc-link voltage ripple.

Index Terms: Controller, dc component, proportional-integral resonant (PIR) transformer less three-phase PV inverters, virtual capacitor.

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