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DC Bus Voltage Ripple Control of Photo Voltaic Inverter in Low Voltage Ride-Trough Operation

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Abstract : Using Renewable Energy Resources (RES) as a type of DG unit is developing in distribution systems. The connection of these generation units to existing AC distribution systems changes the structure and some of the operational aspects of these grids. Most of the RES requires to power electronic-based interfaces for connection to AC systems. These interfaces consist of at least one DC/AC conversion unit. Nowadays, grid-connected inverters must have the required feature to support the grid under sag voltage conditions. There are two curves in these conditions that show the magnitude of the reactive component of current as a function of voltage drop value and the required minimum time value, which must be connected to the grid. This feature is named low voltage ride-through (LVRT). Implementing this feature causes problems in the operation of the inverter that increases the amplitude of high-frequency components of the injected current and working out of maximum power point in the photovoltaic panel connected inverters are some of them. The important phenomenon in these conditions is ripples in the DC bus voltage that affects the operation of the inverter directly and indirectly. The losses of DC bus capacitors which are electrolytic capacitors, cause increasing their temperature and decreasing its lifespan. In addition, if the inverter is connected to the photovoltaic panels directly and has the duty of maximum power point tracking, these ripples cause oscillations around the operating point and decrease the generating energy. Using a bidirectional converter in the DC bus, which works as a buck and boost converter and transfers the ripples to its DC bus, is the traditional method to eliminate these ripples. In spite of eliminating the ripples in the DC bus, this method cannot solve the problem of reliability because it uses an electrolytic capacitor in its DC bus. In this work, a control method is proposed which uses the bidirectional converter as the fourth leg of the inverter and eliminates the DC bus ripples using an injection of unbalanced currents into the grid. Moreover, the proposed method works based on constant power control. In this way, in addition, to supporting the amplitude of grid voltage, it stabilizes its frequency by injecting active power. Also, the proposed method can eliminate the DC bus ripples in deep voltage drops, which cause increasing the amplitude of the reference current more than the nominal current of the inverter. The amplitude of the injected current for the faulty phases in these conditions is kept at the nominal value and its phase, together with the phase and amplitude of the other phases, are adjusted, which at the end, the ripples in the DC bus are eliminated, however, the generated power decreases.

Keywords : renewable energy resources, voltage drop value, DC bus ripples, bidirectional converter
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