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Improved three-vector based dead-beat model predictive direct power control strategy for grid-connected inverters

Key words: Grid-connected inverter; Model predictive control; Direct power control; Three vectors; Constant switching frequency; Power errors

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Motivations

1. Power qualities become severe with the increasing use of renewable energy resources (RES).

2. As an interface between RES and the power grid, the three-phase grid-connected inverter (GCI) plays a more and more important role in power systems.

3. Predictive control is advanced with fast dynamic responses, but the steady performance is not satisfactory.

4. In the traditional three-vector based model predictive direct power control strategy, power ripples and current distortions are generated.

Main ideas

1. The power ripples and current distortions in the conventional three-vector based MPDPC strategy are explained because of the negative duration time of the inverter vectors.

2. Negative duration time appears because of the inappropriate method of selecting the inverter vectors based on the angular position of the power grid voltage.

3. The inverter vectors are selected based on power errors in the novel MPDPC strategy, which eliminates the negative duration time and improves the system performance.

Methods

1. Selecting the inverter vector based on the power errors;

2. Calculating the duration times of the selected inverter vectors;

3. Appling the selected inverter vectors and the duration time in a “3+3” symmetrical manner.

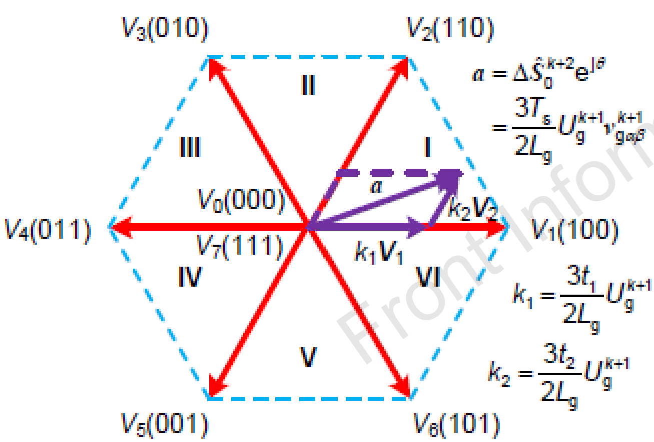

Fig. 4 Selecting inverter voltage vectors based on the position of $\Delta\hat{S}_0^{k+2}e^{j\theta}$

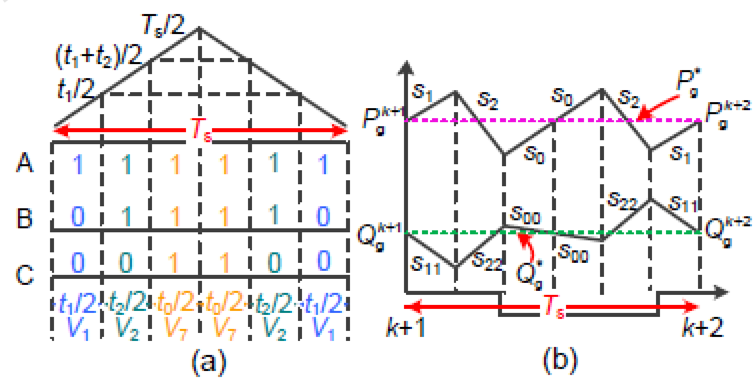

Fig. 5 Symmetrical 3+3 pulse patterns of the three-vector based MPDPC strategy (sector I): (a) pulse patterns in sector I; (b) power variations

Major results

Power ripples and current distortions can be suppressed.

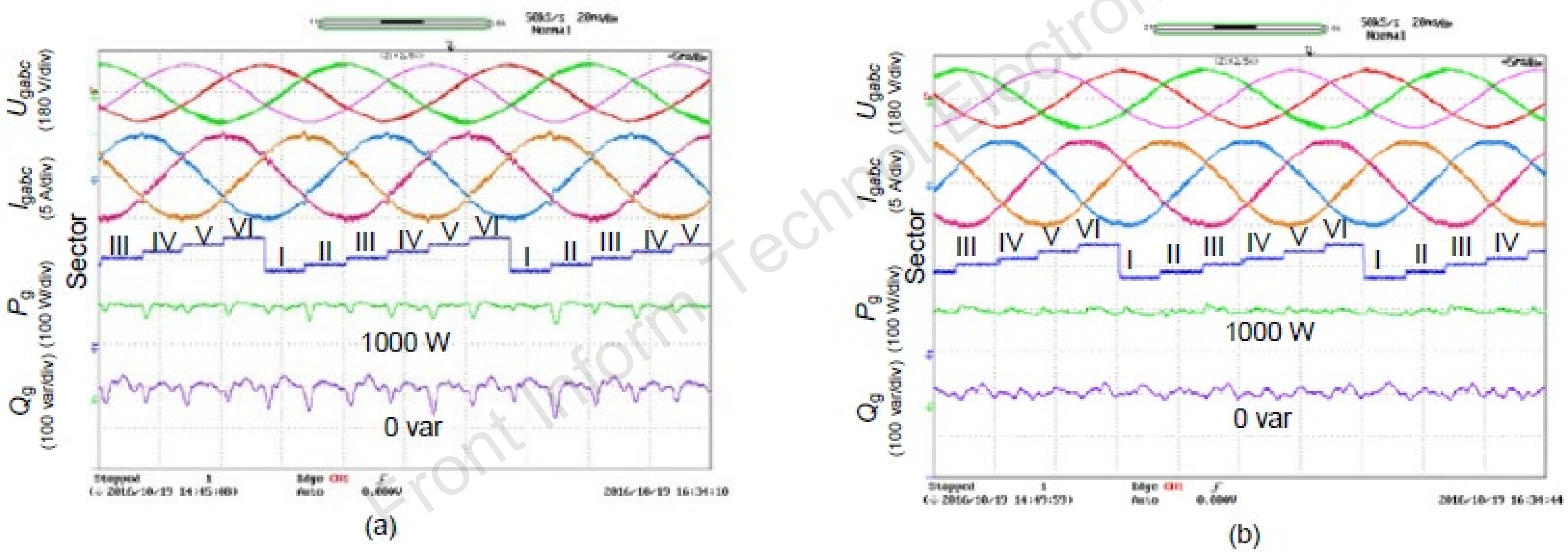

Fig. 8 Comparisons between steady-state responses of the conventional and proposed three-vector based MPDPC strategies with active power equal to 1000 W and reactive power equal to 0 var: (a) conventional three-vector based MPDPC strategy; (b) improved three-vector based MPDPC strategy

Conclusions

1. Two adjacent active inverter voltage vectors and one zero inverter voltage vector are applied during every duty cycle, and thus the switching frequency is kept constant.

2. The proposed method of selecting the inverter voltage vectors based on active and reactive power errors can eliminate power ripples and further improve the steady-state performance.

3. The iterative computation process in the conventional predictive control strategy is avoided. Thus, the execution time can be decreased, and less calculation capacity of the DSP is demanded.

4. Dynamic responses of the improved three-vector based dead-beat MPDPC strategy are fast.