A New Five-Level CSI for Grid Connected Power Conditioner

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1. Introduction

This paper proposes an application of a new five-level current-source inverter (CSI) as a grid connected power conditioner. The proposed five-level CSI is composed of an H-bridge inverter connected with a single DC current module circuit to generate the intermediate level currents of the five current waveform. The simulation results show that the proposed five-level CSI works properly injecting a sinusoidal current into the power grid with a high power factor operation.

2. System Configuration

Fig. 1 presents a circuit configuration of the proposed five-level CSI connected to the power grid. A low pass filter (C*f* and L*f*) is used to filter the harmonic components, e.g. switching harmonics, of the five-level PWM current. The DC current sources are generated using chopper circuits with only a single DC power source. The chopper works as a regulated DC current source for the inverter and the DC current module. The main inverter is a three-level H-bridge CSI. The DC current module connected in parallel with the main H-bridge CSI to obtain a higher level number of output current. The DC current module is composed by a current source, a unidirectional switch and a connecting diode. This circuit functions to synthesize the intermediate current levels of the five-level output current.

The chopper simply consists of a controlled power switches (Q_{c1}, Q_{c2}), smoothing inductors (L_1, L_2) and a free wheeling diodes (D_F). The chopper switch functions to regulate the DC current flowing through the smoothing inductor, and to reduce the smoothing inductor size. It should be noted that only a single DC voltage source (V_{in}) is connected to the choppers to obtain the multiple DC current-sources. The inverter works converting the DC power into AC power that will be injected into the power grid. Proportional integral (PI) regulators are independently applied to regulate the DC currents flowing through the smoothing inductors. A carrier based sinusoidal modulation technique is applied to obtain a PWM output current waveform.

3. Simulation Results

A proposed five-level CSI operated as a grid connected power conditioner is tested through a computer simulation using PSIM software. Fig. 2 shows the waveforms of a five-level PWM output current (I_{5level}), the current injected into the grid (I_{inv}), the grid voltage (V_{Grid}) and the smoothing inductor current waveforms (I_{L1}, I_{L2}) of the proposed five-level CSI. The figure also shows the transient waveforms of five-level and inverter current from 4 A to 8 A. It can be seen that the injected current is an excellent sinusoidal waveform with small distortion, and the inverter works injecting a sinusoidal current with a unity power factor operation.

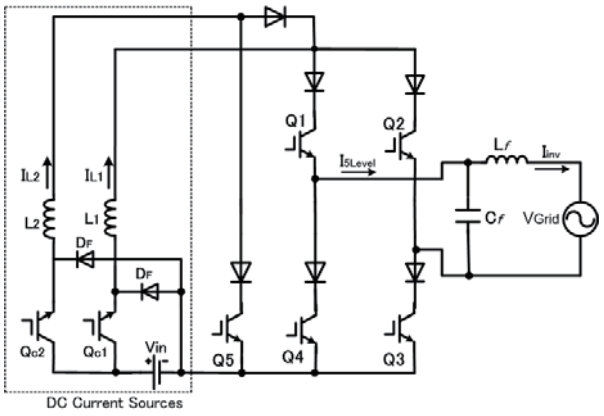

Fig. 1 Proposed five-level CSI with grid connection

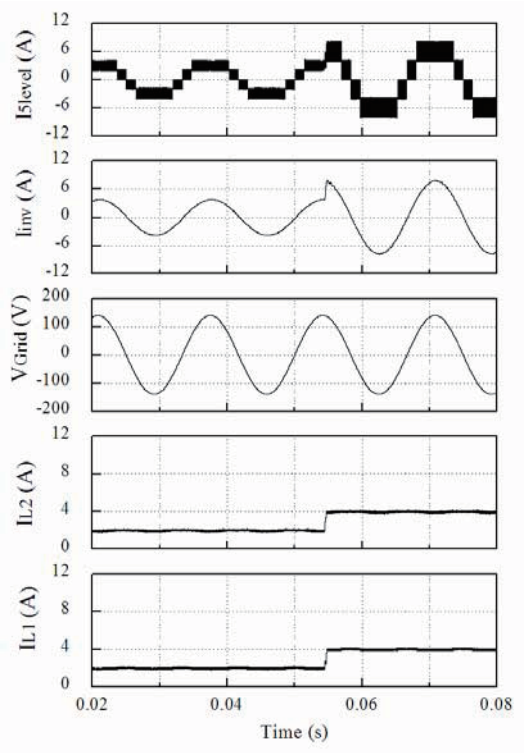

Fig. 2 Simulation result of five-level PWM current, inverter's current, grid voltage, and smoothing inductor current waveforms

4. Conclusion

A new five-level CSI working as a grid connected power conditioner has been proposed. The simulation results show that the proposed CSI worked properly injecting a sinusoidal current to the power grid with a high power factor operation.

References

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