An LCL power filter for grid connected micrcoinverter

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Abstract: This paper proposes to use an LCL filter on two-switch DC-DC flyback microinverter and its voltage for grid connected. With the proposed system, it could possible to improve the quality of the voltage injected into grid and also the quality of outlet power. However, this filter is never used before in the literature for this kind of microinverters. Using Matlab/Simulink software, the results obtained show a better quality of power energy and are in very great conformity with the IEEE1574 standards.

Key words : photovoltaic, microinverter, grid connected, flyback, single stage.

Introduction:

PV systems are used different configurations to achieve high DC voltage output [1]. However, the PV panels often work in mismatching conditions due to different panel orientations and shadowing effects. This mismatching can cause serious problems for the power-conditioning system. In order to deal with the latter drawback, several researchers propose a module-integrated converter [2], [3]. Such a PV system with an individual Photovoltaic DC-AC inverter is called PV flyback microinverters [3]. Hence, a new topology of flyback microinverter proposed in [4], like shown in fig.1 to improve the power generated by photovoltaic systems.

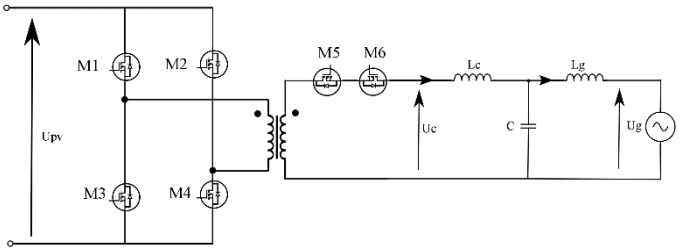

Fig. 1: Topology of microinverter based on two-switch DC-DC flyback converters

Moreover, the output voltage of flyback microinverter contains high-order frequency harmonic caused by the pulse width modulation (PWM) switching frequency. Hence, the output power and the Total Harmonic Distortion (THD) of flyback are improved by the output filters. In this work, we propose to use an LCL filter, like shown in fig. 2 instead of the classical CL filter in order to improve the quality of the output power flyback microinverter and the quality of the signal injected in the grid connected.

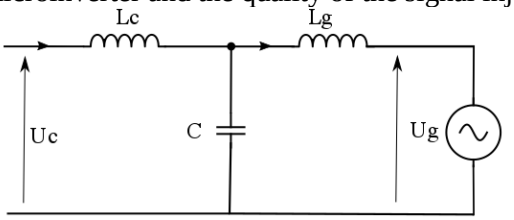

Fig. 2: Circuit diagram of LCL filter

System modeling

Fig. 1 shows the topology of two-switch DC-DC flyback microinverters. The primary side circuit consists of power switches (M1, M2, M3, M4) and a transformer. The secondary-side circuit consists of switches (M5, M6) and LCL filter. Upv is the input voltage. Uac is the output voltage grid connected. The positive half period of the output voltage is formed using two-switch DC-DC flyback converter based on transistors M1 and M4 (transistors M2 and M3 are in state OFF) and the output voltage is forwarded to the grid through the transistor M5 which is in ON state. The negative half period of the output voltage is formed using two-switch DC-DC flyback converter based on transistors M2 and M3 (transistors M1 andM4 are in state OFF) and the output voltage is delivered to the grid through the transistor M6. Then the high frequency harmonics of the formed AC voltage caused by the switching of converter switches are filtered by the LCL filter such in fig. 2. The LCL filter is powered by the voltage Uc, where Lc is the inductor side converter, Lg is the side of the grid connected, C is the capacitor and Ug is the grid connected voltage. Whose values are determined by only a single feedback loop for synchronized the current generated to the grid. Therefore, the advantages of LCL filter are appeared on the system size and on the components capacity. The simulation was performed for 50 Hz microinverter output voltage and for 25 kHz switching frequency using Matlab/Simulink software.

SIMULATION RESULTS

The microinverter output voltage waveforms and spectrum of THD are presented and illustrated in Figure 3. According to the FFT analysis, we have found the waveform comprising 2.92% total harmonic distortion THD that is less than 5% required by the IEE1547 norm at 25 kHz switching frequency and 50 Hz grid operating frequency. Therefore, with LCL filter, we obtained a better accuracy of filtering at the microinverter switching frequency and respect the IEEE1547 norm.

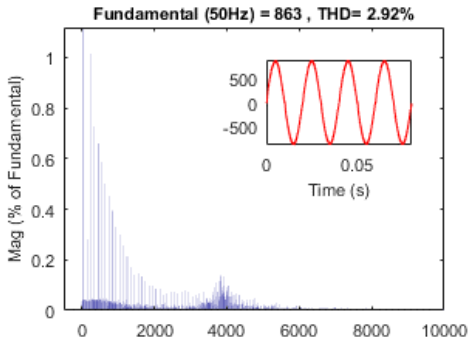

Fig. 3: THD of the output voltage for amp (800 RMS).

CONCLUSION

In this paper, we showed that the THD of the output voltage at 25kHz is less than 5% and respect the requirements of IEEE1547 by using a LCL filter at the output of the two-switch DC-DC flyback converters. So, it can be concluded that LCL filter minimizes the THD of output voltage waveform in order to inject it in the grid connected.

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