A SINGLE STAGE DC-DC CONVERTER FEASIBLE TO BATTERY CHARGING FROM PV PANELS WITH HIGH VOLTAGE STEP UP CAPABILITY

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Abstract. This paper presents a dc-dc power converter integrated in such a way to obtain, in a single conversion stage, the maximum energy extraction from photovoltaic panels, battery charging and discharging dynamic control, and high voltage step-up to feed the inverter DC bus, also operating with soft-switching capability. Although this idea can be applied to most of the high voltage gain topologies, this paper is based on a structure derived from the half-bridge boost converter. Thus, a 500W prototype, with input voltage of 24V and output voltage of 200V, has been developed with the purpose of obtaining the experimental results and validate the proposed converter. High efficiency is achieved, above 92.5%, confirming the expected operation and functionalities necessary for the proposed application.

Key words

Soft-Switching, single conversion stage, battery charger, high voltage step-up, photovoltaic energy.

1. Introduction

The growing use of alternative energy sources, such as photovoltaic panels, wind energy conversion systems, and fuel cells, brings news challenges for the power electronic society and industry. In particular, small and distributed generation systems, isolated or grid-connected types, are the future trends for this technology. It is predictable that in the future most of small consumers can act as an energy seller to the utility. Then the optimization of the efficiency, volume, weight, and cost of power converters are key features to the viability of these technologies.

In the last few years, photovoltaic panels were used only in isolated systems, in order to charge battery banks or in pumping systems, and the traditional power converters were able to achieve maximum power point operation and battery charge control. Nowadays, many systems use an ac power supply and a low voltage inverter associated with a low frequency transformer to provide a sinusoidal voltage waveform with the appropriated voltage level. However, this solution presents high weight and appreciable losses due to the high currents processed by the inverter and due to the low frequency transformer. Thus, an additional stage is necessary to step the low level voltage up from the battery bank (12V, 24V, or 48V) to the higher voltage level of the inverter dc link (200V or 400V). As traditional step-up converters are not feasible to provide such high voltage gain, typical solutions use one high frequency isolated stage to achieve the high step-up voltage gain. Recently, nonisolated dc-dc converters with high voltage gain capability were successfully introduced [1], [2]. However, in systems where photovoltaic panels and battery banks are required, two dc-dc stages are still necessary, as shown in Fig. 1a.

Within this context, this paper proposes the integration of the battery charger stage, the photovoltaic power stage and the high voltage step-up stage in a single-stage power converter. From this new concept, many high step-up voltage power converters can be obtained resulting in new topologies with all aforementioned characteristics.

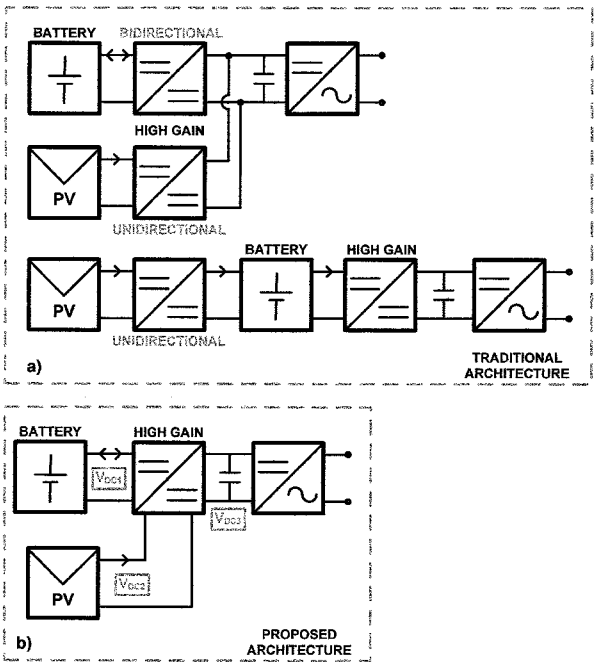

Fig. 1. a) Conventional Architecture b) Proposed Architecture

2. Conception of Topologies

Some high voltage gain topologies have three dc links as shown in Fig. 1b, where V_{DC3} feeds the inverter with a higher voltage than that of the remaining ones. According to the proposal, the battery bank and the photovoltaic panel can be connected to the low voltage V_{DC1} or V_{DC2}, depending on the available voltage levels. Considering typical applications under 2kW, battery banks voltage levels can be 12V, 24V or 48V (in order to avoid the connection of many units in series) and photovoltaic panels can be arranged to establish a dc link