

Correspondence

Comments on “An Efficient Partial Power Processing DC/DC Converter for Distributed PV Architectures”

Teuvo Suntio, *Senior Member, IEEE*,
and Alon Kuperman, *Member, IEEE*

Abstract—In this paper, “An Efficient Partial Power Processing DC/DC Converter for Distributed PV Architectures” by Agamy *et al.* (*IEEE Trans. Power Electron.*, vol. 29, no. 2, Feb. 2014), a dc–dc converter for distributed photovoltaic plant architectures, capable of performing series-type partial power processing under maximum power point control was proposed and tested for various performance parameters. The purpose of this note is correcting (*IEEE Trans. Power Electron.*, vol. 29, no. 2, Feb. 2014) by proving that while the overall operation and results are technically correct, the proposed converter is actually a boost stage performing full rather than partial power processing.

Index Terms—DC–DC conversion, distributed photovoltaic plant architectures, partial power processing.

IN [1] and [2], high-efficient high power density series-type partial power processing topology, implemented with silicon carbide devices, maximizing solar energy harvesting capabilities, was discussed. Series-type partial photovoltaic power processing arrangement under consideration is shown in Fig. 1, where v_{IN} is photovoltaic module voltage, regulated by a maximum power point tracker; v_S is the dc–dc converter [operating as partial power processor (PPP)] output voltage and $v_{BUS} = v_{IN} + v_S$ is grid-connected inverter-regulated input voltage. As explained in [1] and [2], PPP rating depends on the v_{IN}/v_{BUS} voltage ratio.

The dc–dc power stage, proposed in [1] and [2] as a series-type PPP, is shown in Fig. 2. During a switching period T_S , the switch S is ON during $d \cdot T_S$, where d is the pulse width modulation duty cycle. Consequently, resulting one-switching-cycle averaged model of the converter, operating in continuous conduction mode, is shown in Fig. 3 and described by the following system of equations:

$$\begin{aligned} C_{IN} \dot{v}_{IN} &= i_{IN} + C_{IN} \dot{v}_S - i_L \\ L \dot{i}_L &= v_{IN} - d' v_{BUS} \\ C_S \dot{v}_S &= d' i_L - i_{BUS} \end{aligned} \quad (1)$$

with $d' = 1 - d$. Forcing derivatives of (1) to zero, steady-state operating point of the circuit is given by

$$\begin{aligned} I_L &= I_{IN} \\ V_{BUS} &= \frac{V_{IN}}{1-D} \Rightarrow V_S = V_{BUS} - V_{IN} = V_{IN} \frac{D}{1-D} \\ I_L &= \frac{I_{BUS}}{1-D}. \end{aligned} \quad (2)$$

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T. Suntio is with the Department of Electrical Engineering, Tampere University of Technology, Tampere FI-33101, Finland (e-mail: teuvo.suntio@tut.fi).

A. Kuperman is with the Hybrid Energy Sources R&D Laboratory, Department of Electrical Engineering and Electronics, Ariel University, Ariel 40700, Israel (e-mail: alonku@ariel.ac.il).

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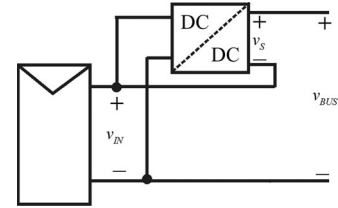


Fig. 1. Series-type partial photovoltaic power processing arrangement.

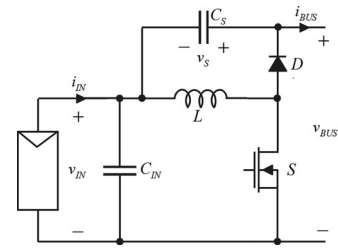


Fig. 2. DC–DC converter proposed as PPP in [1] and [2].

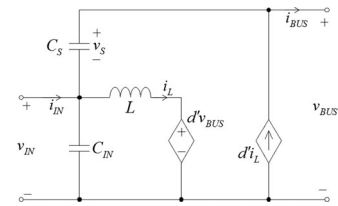


Fig. 3. Averaged model of the converter in [1] and [2].

According to ampere–second balance, average (dc) current through the capacitor C_S is zero. Consequently, active power cannot be transferred from the photovoltaic module to output at dc frequency and the route, referred to as “Direct Feedforward” in [1, Fig. 9(a)] does not exist. This outcome is supported by the fact that since both v_{IN} and v_{BUS} are regulated, v_S is indirectly regulated as well; thus, no average current flows through C_S in steady state. According to (2), the power stage is actually a basic boost converter where all the active power flows through the inductor L ; hence, the proposed converter performs full rather than partial power processing. In order to realize a series-type PPP, direct power link must exist between the source and the load. For detailed explanations, an interested reader may refer to [3].

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