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# Control Laws to Improve Efficiency and Average Life Time of an Adaptive Multi-Phases Converter Dedicated to Photovoltaic Applications

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**Abstract:** In this paper, an Adaptive Multi-Phases Converter (AMPC) is used as an adaptation stage to improve the efficiency and reliability of a photovoltaic power conversion chain. We present a control law which guarantees high conversion efficiency, even in the presence of constantly changing operating point which is principal characteristic of the photovoltaic system . Another control law which consists in the rotations of phases of the converter is also presented. This rotation guarantees a homogeneous aging, increasing the average life time of the converter. Guidelines of these control laws are presented. An experimental prototype has been designed to evaluate the performances of this proposed adaptation stage.

## Key words

Photovoltaic system, power converter, control, efficiency, life-time.

## 1. Introduction:

Photovoltaic converter must be designed considering the singular characteristics of the PV sources, such as its intermittence and above all its changeability. The solar array energy production is not constant and it changes depending on irradiation and temperature. These changes are directly dependant on the season of the year, the hour of the day and the weather.

The efficiency of a classical power converter presents a maximum value ($\eta_{MAX}$) to a given input power (nominal power, $P_{nom}$). The converter efficiency decrease when the input power is lower or higher than this nominal power value. In many power management applications, the design of the converter is made by referring to a fixed operating point (nominal power), set with the maximum efficiency. However, in photovoltaic systems it is not possible to fix an operating point, due to its constant power production changes. In this case, the maximum efficiency of the power converter is also obtained when the power supplied by the photovoltaic module is equal to the nominal power.

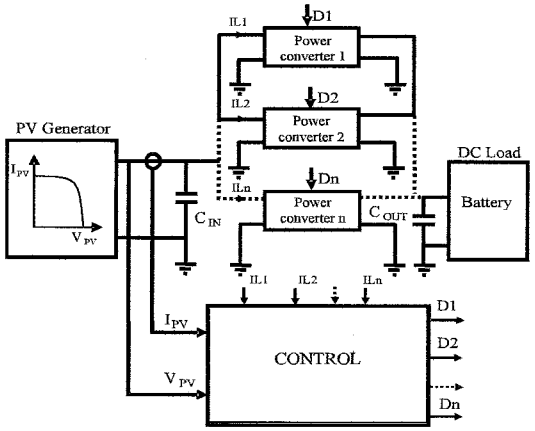


Fig. 1. Photovoltaic conversion chain realized with *n* power converters connected in parallel.

In this paper, the Adaptive Multi-Phases Converter (AMPC) solution is presented. The objective is to obtain a high efficiency of the power converter for a large power range. This solution is inspired in a well known technique used in high power applications. It consists in a parallel association of switching converters. This connection mode allows a uniform distribution of the global power among the dc-dc converters. This approach offers some advantages compared with a single high power converter. Paralleling mode increases the power processing capability and improves the reliability because stresses are better distributed and fault tolerance is guaranteed [1, 2].

This paper presents different control laws to improve the performances in term of efficiency and life-time of the AMPC. The first law guarantees that the converter works with a high efficiency every time. Moreover, in order to avoid the premature ageing of one phase, a control law consisting in the phase rotation of the converter is integrated.