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PFC Single-Phase AC/DC Boost Converters: Bridge, Semi-Bridgeless, and Bridgeless Topologies

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Abstract: Power Factor Correction (PFC) single-phase AC/DC converters are used in several power electronics applications as full wave control rectifiers improving power quality and providing high standards of efficiency. Many papers dealing with the description or use of such topologies have been published in recent years; however, a review that describes and organizes their specific details has not been reported in the technical literature. Therefore, this paper presents an extensive review of PFC single-phase AC/DC converters operating with the Boost converter topology for low and medium voltage as well as and power appliances. A categorization of bridge, semi-bridgeless, and bridgeless, in accordance with the construction characteristics, was carried out in order to unify the technical terminology. Benefits and disadvantages are described and analyzed in detail. Furthermore, a comparison performance in terms of PFC, Total Harmonic Distortion (THD), power capacity, electromagnetic compatibility (EMC), number of elements, and efficiency is included.

Keywords: single phase AC/DC converter; bridge; semi-bridgeless; bridgeless; boost converter; power factor correction; review

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1. Introduction

Conventional diode rectifiers convert an AC supply into a DC voltage draw pulsed current from the supply network, which increases electromagnetic interference (EMI), reduces energy efficiency, and decreases the capacity of the network to carry electrical power [1,2]. An alternative for overcoming these issues in power systems is the use of Controlled Boost Power (CBP) converters instead of conventional diode rectifiers [3–6]. CBP converters implement the Power Factor Correction (PFC) technique that consists of controlling the AC current demanded from the network in such a way that AC current is sinusoidal and in phase with the voltage of the supply network and, at the same time, they perform DC voltage regulation in their output. Basically, CBP converters behave as a resistive load for the electrical network, improving the power quality and overall efficiency and also by helping comply with the harmonic regulation IEC 1000-3-2 [7–11]. Another important aspect is that CBP converters may also avoid the use of active power filters between the power network and loads, which yields a more economic and suitable solution in these kinds of applications [12,13]. The implementation of CBP converters contributes to the better use of power networks avoiding reactive and harmonic components of power flow through the power system; consequently, energy losses are reduced in transmission and distribution lines, and the energy quality is improved. In general terms, the improvement of power quality by means of CBP converters not only for PF correction but also for EMI and THD_i reduction are issues that concern the users, distributors, and generators [14–16].