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Comparative Analysis and Performance Investigation Of Single-Phase Improved Power Quality Converter

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Abstract- This paper deals with the comparative analysis and performance investigation of single-phase improved power quality converters to compensate the harmonics of non-linear load in order to improve the power quality. The comparative analysis of various IPQC topologies and detailed performance investigation of unidirectional boost converter has been done. Various simulations have been presented under the steady state for comparative performance evaluation to achieve better utilization and control of IPQCs. The results show an inherent power quality improvement in terms of reduced Total Harmonic Distortion (THD) of source current and Power Factor Correction (PFC) properties to a large extent. The simulation results have been further aided and confirmed by experimental results obtained on a hardware prototype of a single phase, unidirectional AC/DC boost-converter.

Keywords- Improved power quality converters (IPQCs), Total harmonic distortion (THD), Power Factor Correction (PFC), Switch mode power supply (SMPS), Electromagnetic interference (EMI) and Radio frequency impedance (RFI).

1. INTRODUCTION

An ac to dc converter is a necessary part of any power supply unit utilized as a part of the every electronic hardware. Additionally, it is utilized as an interface between utility and the majority of the power electronic supplies. These electronic supplies frame a noteworthy piece of load on the utility. For the most part, to convert line frequency ac to dc, a diode bridge rectifier is utilized. To diminish the swell/ripples in the dc yield voltage, a substantial filter capacitor is utilized at the rectifier yield. In any case, because of this filter capacitor, the current drawn by this converter is peaky in nature. This input current is rich in low order harmonics. Likewise, as power electronic supplies are progressively being utilized as a part of power conversions, they infuse low order harmonics into the utility. Because of the appearance of these harmonics, the total harmonic distortion (THD) is high and the input power factor (IPF) is poor. Because of issues connected with low power factor and harmonics, utilities will uphold harmonic guidelines and rules which will restrain the measure of current distortions permitted into the utility and in this manner the diode rectifiers may not be used. In order to overcome the limitations of phase controlled converters, Improved Power Quality Converter (IPQC) are proposed. These mostly employ an AC/DC rectification stage followed by a DC to DC conversion stage for effective voltage control. DC to DC converters [1] when connected across a rectified AC line, exhibit an inherent power factor correction property.

The main motivation behind this work is to design a prototype of IPQC that solves power quality problem [2] otherwise introduced by conventional converter. The challenges to be faced in the design of such AC/DC power supply are in achieving:

a) high power factor,
b) low THD,
c) high efficiency along with particular line and load conditions,
d) high power density or reduced size,
e) high reliability, and
f) low system cost

2. POWER FACTOR CORRECTION AND ITS USES

Decrease of line current harmonics is required so as to follow the standard. This is commonly referred to as the power factor correction – PFC, which may be misdirecting. At the point when an electric load has a PF lower than 1, the apparent power conveyed to the load is more prominent than the genuine active power that the load devours. Just the active power is equipped for doing work, however the apparent power decides the measure of current that streams into the load, for a given load voltage. Power factor correction (PFC) is a strategy of neutralizing the undesirable impacts of electric loads that make a power factor (PF) that is under (1). The power factor is characterized as the proportion of the active force P to the apparent force S:

$$PF = \frac{P}{S} \quad (1)$$