

PFC boost converter with GaN technology

Degree programme : BSc in Electrical Engineering and Information Technology | Specialisation : Electric Energy and Renewable Systems
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In this project, two different power factor corrector (PFC) boost rectifier topologies were investigated: the classical PFC and the Bridgeless Totem Pole PFC (BTPPFC). Prototypes were developed and shall be investigated experimentally. The topologies were based on the latest GaN technology semiconductors.

Introduction

Boost converters are among the most common converters for supplying appliances connected to the single-phase network. The 3 parameters that characterise the performance of such a converter are :

- Efficiency, i.e. small losses
- Power factor, i.e. clean currents
- Power density, i.e. small volume

As these converters are widely used, techniques to improve the performance of these converters have a significant impact on the quality of the electrical network and on the consumption of electrical energy. We are interested in improving these converters through the application of GaN technology semiconductors.

Background

Power Factor Correction (PFC)

PFC are a series of methods used to improve the Power Factor of a device. Displacement problems are solved by using reactive components that compensate for the reactive power of the circuit, while for distortion problems there are two main options: passive PFC and active PFC.

In this project, we focused on two types of active PFC: the classic PFC and the bridgeless totem pole PFC (BTPPFC) (see figure 1). These two converters use switches to modulate the distorted wave and transform it into a sine wave.

GaN technology

Gallium Nitride (GaN) is a very hard, mechanically stable wide bandgap semiconductor. With higher breakdown strength, faster switching speed, higher thermal conductivity and lower on-resistance, power devices based on GaN significantly outperform silicon-based devices.

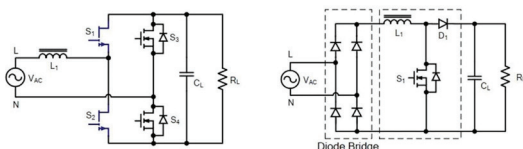


Figure 1 - Left: Classical PFC converter, Right: BTPPFC converter [GaN Systems - GS665BTP-REF-rev170905.pdf]

Goals

The objective of this project is the development and realisation of two PFC boost converter prototypes with GaN technology. More precisely, the missions are as follows :

- Research and personal study on converter theory
- Study of the converter in simulation
- Dimensioning the converter components
- Realisation of the schematic
- Realisation of the PCB layout
- Prototype assembly and testing
- Experimental investigation of prototypes

Result

In the first phase of the project, all components required for prototype development were dimensioned. Once the dimensioning phase was completed, we moved on to the realization of the schematic and the PCB. When designing the PCB, attention had to be paid to several aspects especially in the high-power part. After the PCB design phase, the prototypes had to be assembled and a whole series of tests carried out to check that the circuit worked properly. At the end of the project, all of the objectives listed above were achieved except for the last one. Therefore, a control system must be implemented in the future in order to perform more advanced testing and investigation.



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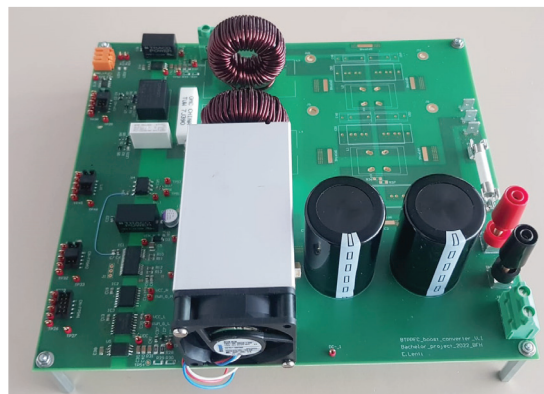


Figure 2 - Final prototype (BTPPFC)