SUMMARY

The feasibility of the usage of Gallium Nitride transistors in half-bridge DC-DC converter applications have been evaluated in the several steps. In the first chapter, GaN material properties have been examined. It was concluded that one of the key features of GaN devices is its two-dimensional electron gas that provides a large number of free electrons and is based on material piezoelectric properties. Five different enhancement mode transistor structures have been studied, and their benefits and drawbacks explained.

In the next chapter, EPC2021 was selected as a transistor of choice for this project. Two circuits have been designed: one that implements non-isolated UCC27611 GaN gate driver, and the other that has ADuM4121 isolated IC. Both solutions include 5V regulated and isolated power supply, and pin connections so that designed boards can be easily plugged in to an external circuit and solve the main thesis problem. While working on circuit and PCB layout design, several challenges have been identified. High *dv/dt*, *di/dt*, and Common Source Inductance are among a few that affect the efficiency of GaN circuits the most. Some ideas were suggested on how to reduce or even avoid them.

In the last chapter, double pulse methodology was used to test EPC9203 board main functionality. Voltage overshoots are of a primary concern, as the maximum allowed voltage for the selected transistors is 80V (continuous). In the experiment, it was confirmed that with up to 92V pulsed voltage overshoot, it is relatively safe to use the device and do not overload it. In the second test, overshoots were tested over the range of duty cycles, and it has been noted that they do not affect neither the output voltage nor the peak voltage, but the output current. In the last experiment, the stability of propagation delays has been ensured.

Yet, due to the lack of transformer drivers SB6505B and SN6501 on the market, it was virtually impossible to test the designed boards. For this reason, it was decided to test EPC9203, designed by Efficient Power Conversion corporation, and later use these findings for further investigation. In the future research, the aim is to test designed PCB boards, both with isolated and non-isolated drivers, compare their parameters and functionality, measure switching and gating losses, and, finally, test them in an external circuit. EPC9203 board results will be used as a reference. Overall, the main thesis objectives have been accomplished and future research questions identified. Undeniably, GaN transistors offer a vast variety of problems to investigate and solve.