ABSTRACT

A power supply is an essential part of almost every electronic device and the current trend is towards the miniaturization of these devices. It is thus desirable to also attempt to reduce the size of the power supply and it is possible to achieve this objective by increasing the power density which is attainable by decreasing the size of the passive/energy storage components such as the inductors, capacitors and the transformer. The size of these components can also be decreased by increasing the switching frequencies.

Linear power supplies use bulky line frequency transformers and heat sinks and are thus not capable of providing a significant opportunity to reduce their size and weight. Switch Mode Power Supplies (SMPS) use higher switching frequencies, which replaces the bulky line frequency magnetics by smaller high frequency magnetics which are then able to offer significant size and weight reductions. The efficiency and size of the SMPS depends on a suitable switching frequency.

Previously, the SMPS were implemented using bipolar power devices and their switching frequency range was limited to a range of a few kHz. With the availability of modern and efficient power MOSFETs, it is possible to switch the SMPS from several kHz to a MHz range. In addition, core based transformers were previously used in SMPS. These transformers have hysteresis and eddy current losses. Their switching frequency was limited to several hundreds of kHz. Recent research has produced energy efficient multilayered PCB transformers which can be implemented in SMPS for power and signal transfer applications, in the MHz frequency range. Thus, with the emerging power devices in GaN and SiC technology and the development of high frequency multilayered PCB power transformers, it is now possible to design high frequency and power efficient isolated converters.

The focus of the research is to design, implement and evaluate energy efficient AC-DC and DC-DC isolated converter topologies. These converters are designed by using the latest power electronic devices and PCB transformers. They are switched in the MHz frequency range.

In this thesis, two DC-DC converters, half bridge and full bridge, are designed, implemented and evaluated. These converters are switched in the MHz frequency range. The energy efficiency of the converter is measured and analysed by varying different circuit parameters. Feedback analysis is made in the case of the Half Bridge converter. The opto-coupler and auxiliary feedback techniques are implemented, measured and analysed in a high frequency half bridge converter using a PCB power transformer. The feasibility of the feedback signal, using the auxiliary winding of a PCB power transformer, is discussed.

The multilayered PCB transformers used in the converter circuits have provided a major contribution with regards to both the energy efficiency and size compactness. This research work is a initial step in the design, implementation and analysis of SMPS operating in the MHz frequency region, using PCB transformers.