INDUSTRIAL BASED SWITCHED-MODE POWER SUPPLY: DESIGN A 48V, 4A CHARGER WITH REGULATING SYSTEM

Prepared by: Loh Sean Bein

ABSTRACT

Linear power supply is widely used in industries to supply regulated power. It is large, inflexible, and dissipates large power in ohmic losses to regulate. Therefore, has low efficiency (50%). However, with recent advances in semiconductor, magnetic and passive technologies, power supply designers have incorporated the principles of high frequency switching and discovered the Switched-Mode Power Supply (SMPS) method which has high efficiency (85%). This results in many SMPS design with different topologies being available in the market today.

This industrial-based project serves to provide a SMPS with high power output rating at 220W. With rapid growth of semiconductor technology, there are semiconductor components that can support the system in providing high output power rating. They are utilised in this project. A proven PTP-2038 200W ATX Power Supply Unit is set as benchmark for this project. This project hopes to achieve efficiency higher than the PTP-2038 SMPS (75%). Besides, this project aims to provide better features that are necessarily required by industrial standards without compromising its advantage in complexity and costs. The technical requirements set by the company emphasize mainly on the features and efficiency which is the where this project is headed to.

At initial stage, a rectifier circuit was designed and tested to rectify ac input into dc. Next, the flyback topology was chosen and designed. It is the most challenging topology as it involves the design and consideration of inductive Flyback transformer in the system. It was chosen because it has high efficiency since power is transferred in the form of inductive energy through primary-secondary transformer isolation (no ohmic contact). From there, comes the selection of control integrated circuit (IC) which is decisive in the system outcome. The IC decides if the system has Power Factor Correction (PFC) and Pulse Width Modulation (PWM). The IC will also decide if the system has the necessary protection features to suit the industrial needs. Among the shortlisted ICs with both PFC and PWM features, the System General SG6902 has 20 pins and has many safety features but the design is complex and costly. Motorola TL494 provides precise frequency and duty cycle control but the energy consumption of the controller IC is high in the long run, which defeats the purpose of this project. The UC3842 by On Semiconductor was chosen as it has high control response, operates in current-controlled Current-Continuous mode (CCM) ideal for Flyback topology, is easily available, has the lowest cost, consumes least energy in long term, has minimal design, and is integrated with important features such as peak current limiter and overvoltage protection. The final step is to design a voltage feedback controller on the secondary to improve the response rate of the regulating control IC.

To achieve optimal operation in experimentation, simulation software is used as aid in design to predict the outcome in terms of heat dissipation, power dissipation, stability response and finally to provide the simulated outcome for reference purpose on during experimentation.

The outcome of this project proves that the SMPS has met its technical specifications successfully with an innovative solution provided at the end to overcome

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the limitation of SMPS topologies that are not able to support power output rating above 150W previously.