

# Generalized Simulation Model for a Switched-Mode Power Supply Design Course Using MATLAB/SIMULINK

Wei-Hsin Liao, Shun-Chung Wang, and Yi-Hua Liu, *Member, IEEE*

**Abstract**—Switched-mode power supplies (SMPS) are becoming an essential part of many electronic systems as the industry drives toward miniaturization and energy efficiency. However, practical SMPS design courses are seldom offered. In this paper, a generalized MATLAB/SIMULINK modeling technique is first presented. A proposed practical SMPS design course at Lunghua University, Taiwan, which incorporates this technique, is then described. In order to validate the correctness of the proposed modeling technique, four prototype SMPS are provided in this paper. These prototype circuits also serve as the laboratory section of the proposed course. The main objective of the course is to teach final-year undergraduate students and first-year Master's students how to design an SMPS in real life. The positive response from students indicates that the proposed technique is useful for SMPS design courses.

**Index Terms**—ac–dc power conversion, dc–dc power conversion, power electronics, pulse-width modulated power converters, switched-mode power supplies (SMPS).

## I. INTRODUCTION

**P**OWER electronics is recognized as the enabling technology propelling many hi-tech applications, such as personal computers, home appliances, telecommunications, automation and process control, robotics, transportation, and all forms of environmentally friendly energy conversions. Nowadays, as the industry drives toward miniaturization and energy efficiency, switched mode power supplies (SMPS) have become the dominant type of power supply units employed across practically the full spectrum of applications. This extensive use of SMPS in electronic products and systems makes the fundamental understanding of SMPS a necessity for electronic engineering students and professionals. This trend has resulted in an increasing interest in providing power electronic courses at the senior undergraduate and the graduate levels in various institutions [1]–[7]. Traditionally, SMPS are taught as part of a typical introductory undergraduate elective course in power electronics [8]–[11]. However, the practical design of SMPS

requires design expertise, which can only be gained with years of experience [12]–[16].

An SMPS can be a fairly complicated circuit, as can be seen from the block diagram shown in Fig. 1 [12]. The ac supply is first rectified, and then filtered by the input capacitor to produce a rough dc voltage. This dc voltage is next applied to a power factor correction (PFC) preregulator followed by output dc–dc converter(s). Most of the SMPS manufactured today for ac input applications include the PFC front end to improve the power factor and meet the harmonic regulations such as EN61000-3-2. Downstream, a dc–dc converter is used to generate a set of dc voltages required for the load, and this normally also provides input-to-output isolation. Regulation of the output is carried out by the control/feedback block, which in practice can be implemented using a commercial pulse-width modulation (PWM) IC. There are a number of topologies used in a dc–dc converter, and a large variety of PWM ICs are suitable for these topologies. The selection of the right topology and controller depends on the specific requirements of the power supply and the designer's personal experience. These issues are important for practical SMPS design, but are seldom discussed in power electronics courses [13]–[16].

Reference [13] presents experimental equipment on which students can safely observe the operation condition of some power converters, but the types of SMPS experiments that can be performed are limited. In [14], only power supplies consisting of a simple transformer, a rectifier, and a filter were studied. Reference [15] proposed a switching converter circuit simulation using MATLAB/SIMULINK and focused on closed-loop behavior and feedback controller design. In [16], a new course in practical SMPS design was described, but only two nonisolated switching power converters were considered. This paper proposes teaching SMPS design based on MATLAB/SIMULINK modeling, and four prototype SMPS are then given for the laboratory session. Compared to [15] and [16], both the simulation and experimental parts of SMPS design are addressed here, as are all the elementary types of SMPS.

In this paper, a generalized MATLAB/SIMULINK dynamic behavior modeling technique for SMPS is presented. MATLAB/SIMULINK is frequently used in design courses to facilitate the learning of some nonlinear, complex systems [17]–[22]. The MATLAB/SIMULINK environment is well suited to practical SMPS design course purposes because the SIMULINK environment has the advantage that models are entered as block diagrams with an intuitive graphical interface. Since the model parameters can be entered from menus, and changed interactively during a simulation as a block, students can conduct the

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W.-H. Liao and Y.-H. Liu are with the Department of Electrical Engineering, National Taiwan University of Science and Technology, Taipei 106, Taiwan (e-mail: d9709202@mail.nust.edu.tw; yhliao@mail.nust.edu.tw).

S.-C. Wang is with the Department of Electrical Engineering, Lunghua University of Science and Technology, Taoyuan 33306, Taiwan (e-mail: wangsc@mail.lhu.edu.tw).

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# Design Of Switched Mode Power Supply Using Matlab Simulink

**Luca Corradini, Dragan  
Maksimovic, Paolo Mattavelli, Regan  
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## **Design Of Switched Mode Power Supply Using Matlab Simulink:**

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