**AIN SHAMS UNIVERSITY**

**FACULTY OF ENGINEERING**
**Electronics and Communications Engineering Department**

# Smart Power IC's for Switched Mode Power Supplies

A Thesis

submitted in partial fulfillment for the requirement of the degree of
**Master of Science in Electrical Engineering**
(Electronics and Communication Engineering)

by

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# STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Electrical Engineering.

The work included in this thesis was carried out by the auther at the Electronics and Communication Engineering Department, Faculty of Engineering, Ain Shams University.

No part of this thesis has been submitted for a degree or qualification at other university or institution.

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# ABSTRACT

-This dissertation demonstrates the SMPS in general.

- Analysis for ATX 200W PC SMPS circuit.

- Simulation of the circuit with power switching transistors connected in push-pull topology and make a simulation for control circuit PWM and constant frequency at approximately 100kHz instead of the control IC TL494 in the circuit by using the block diagram of the control IC. Analysis of the circuit is provided.

- verification the circuit by comparison the simulated with the actual circuit from efficiency point of view.

Measuring the output regulation with change in the mains voltage and the output regulation with change in the load values

# References and Selected Readings


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## الملخص العربى

دوائر قدرة ذكية متكاملة لمنابع قدرة مفتاحية

- مسح لدوائرمنابع قدرة مفتاحية .
- التعرض لدائرة قدرة مفتاحية للحاسب الشخصى.
- محاكاة دائرة مماثلة باختلاف نسق سويتشات الخرج لنظام الدفع والجذب مع عما نموذج لدائرة التحكم لتعديل عرض النبضة.
- تحقيق الدائرة بمقارنة المحاكاة مع الدائرة الفعلية من وجهة نظر الكفاءة و قياسات انتظام الخرج عند تغير جهد المنبع وانتظام الخرج مع الحمل

# شكر و تقدير

في البداية ، احمد الله العلي العظيم حمدا كثيرا علي نعمه و بركاته التي لا تعد و لا تحصي و على عونه و توفيقه لي في جميع اموري. و اوجه اعمق الشكر والتقدير و العرفان الى اسرتى علي رعايتهم و مساعداتهم العظيمة و المتواصلة.

كما اود ان اعبر عن خالص الشكر لجميع اساتذتي بقسم هندسة الالكترونيات و الاتصالات بكلية الهندسة جامعة عين شمس لتوجيهاتهم و دعمهم و رعايتهم لي.

و انه لمن دواعي الشرف و الفخر ان انتسب لهذا القسم.

واتشرف بتوجيه الشكر والتقدير الى:

الاستاذ الدكتور/ **عبد الحليم ذكرى** والدكتور/**محمد حمزة السبع** (المشرفين على البحث) الذين بذلا جهدا ووقتا سخيا فى تقديم الارشادات القيمة والتوجيهات الفعالة مما كان له الاثر الكبير على انجاز هذا البحث واتمامه فى صورته النهائية فهما بحق من الأساتذة الأجلاء.

كما اشكر زملائى الاعزاء بقسم هندسة الاكترونيات والاتصالات جامعة عين شمس لما قدموه من عون واهتمام وروح الاخوة فى المعاملة.

واخيرا، اتوجه بالشكر لجميع الموظفين والفنيين والعمال بكلية الهندسة جامعة عين شمس.

# THESIS ABSTACT

# Smart Power IC's for Switched Mode Power Supplies

This thesis demonstrates design and operations of switching mode power supplies (SMPS) in general and the (PWM) in particular.

In this thesis we demonstrate the power supplies smart power IC's, the different topologies, the kind of control and the choice of semiconductor used in it.

We simulate a PC SMPS circuit and explain the function of its building blocks. Then we precede the simulation of the SMPS where we make a model for the PWM control IC instead of the control IC TL494 in the circuit using its block diagram and reverse engineering techniques.

Then the results of simulation are verified by measuring the output regulation characteristics, the overall efficiency and comparing the measurement with the simulated results. A good agreement between the simulated results and measurements is obtained.

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| Smart Power IC'S For Switched Mode Power Supplies | دوائر قدرة ذكية متكاملة لمنابع قدرة مفتاحية |
|---|---|
| This thesis demonstrates design and operations of switching mode power supplies (SMPS) in general and the (PWM) in particular.<br>In this thesis we demonstrate the power supplies smart power IC's, the different topologies, the kind of control and the choice of semiconductor used in it.<br>We simulate a PC SMPS circuit and explain the function of its building blocks. Then we precede the simulation of the SMPS where we make a model for the PWM control IC instead of the control IC TL494 in the circuit using its block diagram and reverse engineering techniques.<br>Then the results of simulation are verified by measuring the output regulation characteristics, the overall efficiency and comparing the measurement with the simulated results. A good agreement between the simulated results and measurements is obtained. | الهدف الرئيسى من هذه الرسالة هو عمل دراسة نظرية وعملية لاحدى دوائر القدرة الذكية المتكاملة الخاصة بمنابع قدرة مفتاحية، (Switching Mode Power Supplies SMPS).<br><br>يتناول الباحث دوائر منابع قدرة مفتاحية لكونها احدى تطبيقات دوائر القدرة الذكية المتكاملة. حيث يتناول انواعه ونسق المفاتيح وانواع التحكم واختيارالمكونات المستخدمة بهذه الدوائر. كما يقدم الباحث دائرة قدرة مفتاحية للحاسب الشخصى شرحا وتحليلا. وقام بمحاكاة الدائرة وعمل نموذج لدائرة تحكم لتعديل عرض النبضة و قدم منحنيات الكفاءة والخرج مع جهد المنبع عند ثبات الحمل والخرج مع الحمل عند ثبات جهد المنبع. واخيرا قام الباحث بتقديم النتائج ومقارنتها بالنتائج العملية للدائرة و اظهرت المقارنة تطابق النتائج العملية ونتائج المحاكاة عند ترددات 100 كيلو هرتز. |
| **Supervisor** | **المشرف** |

# General Introduction

The integration of medium power switching elements to the low power integrated control circuit is called smart power IC's. Smart power technology requires the marriage of power device technology with CMOS logic and bipolar analog circuits.

Smart power technology provides the interface between the digital control logic and the power load.

One of the important power electronic circuits is that of switched mode power supplies.

In this work a full study of a switched mode power supply (SMPS) is performed.

The aim of this thesis is to predesign a smart power IC for the switched-mode power supply circuit. This has been accomplished by choosing a standard switched-mode power supply circuit used to power the personal computer, simulate its performance and then measure its characteristics. In this way the elements of the switched mode power supply have been specified and characterized; this is the predesign. The next step is to use the smart power IC technology to integrate the control circuit with the switches. But this step cannot yet be implemented as no technology while is available.

The thesis is divided into three chapters and a conclusion as follows:

## Chapter 1

This chapter begins with a general introduction to the main concepts of switching mode power supplies, why using SMPS, the SMPS fundamentals, the common topology used, the method of control and the choice of semiconductors and the block diagram for SMPS

## Chapter 2

This chapter introduces the analysis and measurment of PC SMPS. Starting from the main interface of the circuit and the half bridge topology used in this circuit. The control IC TL494 PWM IC, the voltage mode and the current mode control are also introduced. The bipolar power transistor base drive circuits are presented. the measuring results on the PC SMPS such as the line regulation curve and the voltage regulation curve. Also, signal waveforms are taken on some points of the circuit with emphasis on the control IC and the switching transistors.

## Chapter 3

This chapter introduces the PSpice simulation for the switched-mode power supply circuit. The experimental results are compared to the simulation results.

## Chapter 4

Conclusions and future work are presented at the end of this thesis.