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TK7868.P6 .178 2005



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Computer power supply design / Irwan Shahnizam Md  
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**COMPUTER POWER SUPPLY DESIGN**

**IRWAN SHAHNIZAM BIN MD IDRIS**

**18 NOVEMBER 2005**

“I admit that I/we have read this literature work through my/our observation which has fulfilled the scope and quality in order to be qualified for the conferment of Bachelor Degree in Electrical Engineering (Industry Power).”

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**This Report Is Submitted In Partial Fulfillment of Requirements For  
The Degree of Bachelor In Electrical Engineering (Industry Power)**

**Faculty of Electrical Engineering  
Kolej Universiti Teknikal Kebangsaan Malaysia**

**November 2005**

"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya jelaskan sumbernya."

Tandatangan :  .....

Nama : IRWAN SHAHZAM MD IDRIS

Tarikh : 18 NOVEMBER 2009 .....

**Dedicated to my beloved family...**

## **ACKNOWLEDGEMENT**

First of all I would like to express my gratitude to my supervisor, Pn. Maaspaliza Bte Azri for her guidance and advice throughout the development of this project.

I also would like to thanks my family for their moral support and financial support beside care and their encouragement.

Not forgetting to all my fellow friends, thanks for the suggestions and the help in this project.

Lastly, I would like to extend my appreciation to all those who have directly or indirectly played a part in the completion and suggestion of this project.

## ABSTRACT

Power supply is commonly used in the electrical and electronic appliances. The dc voltage produced by a power supply is used to power all types of electronic circuit such as television receivers, stereo system, VCR, cd player, laboratory equipment and for the computer appliances. The proposed project are designed and develop the power supply for the computer appliances. The proposed system can capable to handle the back up condition. The computer load requires regulated 5V dc power. Sometime, the regulated 5V dc is not constant. It cause by load from computer. Transient voltage disturbance also caused by software, hardware and i/o errors. For the software, transient voltage disturbance once on the logic board have the effect of resetting memory values. Another common symptom of power line disturbances is “read errors” and other error message associated with transfer and recovery of data from disc storage. The proposed system design and develop the dc filter. DC filter can be used to smooth out the dc output voltage of rectifier. The dc filters are usually of L, C, and LC type. The proposed system improved the output signal by design and develop the switching regulators. Dc converters can be used as switching-mode regulators to convert a dc voltage, normally unregulated, to a regulated dc output voltage. Switching regulators are commercially available as intergrated circuits.

## ABSTRAK

Bekalan kuasa selalunya digunakan di dalam barangan elektrik dan elektronik. Voltan arus terus dihasilkan oleh power supply untuk digunakan bagi membekal kuasa kepada semua jenis alat elektronik seperti penerima televisyen, sistem stereo, VCR, pemain cd, kelengkapan makmal dan komputer. Projek yang dicadangkan adalah untuk merekabentuk dan membangunkan bekalan kuasa untuk kegunaan komputer. Projek yang dicadangkan ini juga berkebolehan untuk mengawal keadaan bantuan dimana tenaga elektrik dari sumber utama tidak dapat digunakan. Beban komputer memerlukan 5V arus terus. Kadangkala, 5V arus terus yang diperlukan tidak tetap. Ini disebabkan oleh beban dari komputer. Gangguan voltan selalunya disebabkan oleh penggunaan program komputer, alat komputer dan kesilapan masukan dan keluaran. Bagi program komputer, gangguan voltan pada papan logik boleh mendatangkan kesan keatas nilai ingatan. Selain dari itu, terdapat simptom-simptom lain yang menyebabkan gangguan voltan antaranya ialah “kesilapan bacaan” dan mesej kesilapan yang berkaitan dengan pindah dan perlindungan data dari simpanan cakera. Sistem yang dicadangkan ini adalah untuk mereka bentuk dan membangunkan penapis arus terus. Penapis arus terus selalunya digunakan untuk melicinkan keluaran voltan arus terus. Penapis arus terus selalunya terdiri daripada jenis L, C dan LC. Sistem yang dicadangkan ini memperbaiki isyarat keluaran dengan mereka bentuk dan membangunkan litar pengatur. Penukar arus terus boleh digunakan seperti pengatur untuk menukar voltan arus terus. Pengatur boleh digunakan seperti litar dalaman secara dagangan.



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## CHAPTER 1

### 1.1 Introduction

Few electronic circuits are more common than the dc power supply. The switched circuits are becoming popular, many electronic systems are designed with power supplies which consist of a simple transformer, a rectifier, and a filter to remove ripple voltage from the output. It is not uncommon for a textbook to devote several sections to these power supplies and their filter circuits.

The approximate analysis presented in most textbooks like is not sufficiently detailed for use in the design of power supplies. It assumes very low ripple voltage, constant discharge current, and essentially zero recharge time for the capacitor. No method is given for estimating the RMS current in the transformer windings. Correct power supply design requires knowledge of the current in the transformer windings. Practical designs of power supplies often include circuits in which the ripple voltage is not low and the capacitor recharge time is not near zero. Although it is less important, many power supply circuits also have discharge currents which are not constant. These factors combine to cause unacceptable errors and insufficient information in the analyses presented in most textbooks.

Since power supply design and selection are primary determinants of product safety and EMC compliance, these trends, including the move toward higher operating frequencies for switch mode power supplies (SMPSs), are surveyed. It is concluded that the continuing changes in power supply technology and the regulatory

requirements will require that EMC and product safety specialists work more closely with those involved in the design and selection of power supplies. The goal is to capitalize on new developments without falling victim to one of the technical/regulatory hazards.

## **1.2 Problems Statement**

The current power supply system has many problems. It consist of the input current of the rectifier have harmonics because the rectification process. The electrical noise between live and ground wire and between neutral and ground wire. 5V dc output signal for computer load is not constant. The transient voltages can originate from numerous sources at any time of the day or night and can cause board damage, burned chips and memory loss.

## **1.3 Objectives**

The main objective of this project is to improved the regulated signal. In order to achieve the main objective, the following are conducted:

- Analyze the power supply using Pspice and multisim.
- Design and develop the rectifier circuit.
- Design and develop the filter circuit.
- Design and develop regulator circuit.
- Develop the back up supply for power supply.



## CHAPTER 2

### 2.1 Literature Review of Power Supply

Power supply transformer with full-wave bridge rectifiers usually have rms currents at least twice as large as the dc average load current. If very large capacitors are used to reduced ripple to very small values, the transformer currents will be even larger. The above approach may also be used with taped secondary transformer using only two diodes if the sharing of the currents in the secondary winding is properly considered. In either case, the assumption of ideal diodes provides a conservative design which predicts currents slightly larger than actual currents. (Wesley Sherman et. al,1997)

The use of a combination of electronic and electromechanical switching components have resulted in the implementation of a compact, efficient, affordable and low weight power supply for field testing of soil resistivity. Series resonant coverter features allow IGBT switching at relatively high frequency (35kHz), thus reducing transformer size. Furthermore, the resonant inverter output power control by means of switching frequency variations ensures soft switching of the reed relays used in the output inverter, thus increasing reliability. This electromechanical solution is more efficient, less costly and results in lower weight than a solution based on semiconductor switches. (Jaafari et. al.,1995)

Switching capacitor charging power supplies have reduced the size and cost of power supplies for pulsed power systems. Using simple interfacing techniques it is

possible to use switching power supplies without concern for failure in normal operation or in fault modes.(Andrew H. Bushnell,2002)

Design considerations for new power supplies, based on switched capacitors, have been discussed in the context of application to pocket computer systems. The new power supplies are inductor less and, consequently, suitable for hybridization. The new techniques are also based on the distinguishing characteristics of pocket digital computer systems, in which a switched-capacitor converter can work well, even without close regulation. Moreover, the output capacitor function can be performed mainly by on-board decoupling capacitors. The size of switched-capacitor converters is, consequently, further minimized, and the converters are powered by only one battery. Switched-capacitor converters rated at 12 V/ 12 V, 5 V and 5 V/ 12 V, 12 V were discussed as examples, since these are the most common in pocket computer systems. The computer systems powered by other voltages are rather complicated and are relatively lower in efficiency. Hence, 12 V and 5 V are generally provided as the voltages for pocket computer systems. The described switched-capacitor dc–dc converters are suitable for microcontroller-based car instruments, which are usually powered by a 12- V battery. 5 and 12 V can be obtained by the technique in this paper. As in the cases of intelligent pocket electronic devices, 12-V voltages which are needed for many linear IC's can be generated from a battery lower than 5 V, making the device more compact. As for the cases when the battery voltage is as low as 2.4–2.8 V, more capacitors and diodes are needed to raise the voltage to the desired value.(Jian Liu et. al.,1999)

Arcing occurs in power supplies when the following three conditions are present high voltage across closely spaced features, switching waveforms with large amplitudes and high frequency ringing, conductive contamination such as zinc whiskers that can deposit in the narrow gap. The partial vacuum test can predict the field arcing propensity of a power supply design. If a power supply arcs at -IOT and above, the probability of the supply arcing in the field is high. Feature subjected to - 350V switching voltage should be spaced at least 3mm apart. If the spacing is less

than 3mm, these features should be coated to prevent arcing in the field.(P. Singh et. al.,2000)

In this paper the new method of switch mode power supply (SMPS) design that are based on use of high-frequency amorphous materials with a rectangular hysteresis loop (RHL), are proposed (Volodymyr Yaskiv et. al.,1997). The principle of operation of high-frequency magnetic amplifiers in voltage regulators is explained. Their advantages are adduced in comparison with transistor analogs. The structure multi-channel SMPS with equivalent and independent output channels is shown. The features of the high-frequency non-regulated transistor inverter operation are described. The method of inclusion on parallel operation of separate SMPS is offered. The main specifications of multi-output SMPS and also examples of its designing for computer facilities are adduced

Dielectric barrier discharge is recognized as an efficient method for ultraviolet light generation, ozone production and other technological processes in industry. Common simulation methods for the dielectric barrier discharge load are based on a numerical solving of the state differential equations. This paper presents a faster method, which employs analytical solving of the circuit state equations combined with optimization procedures. This approach reduces the simulation time drastically and allows more sophisticated analysis. This paper introduces the developed approach, frequency analysis of the dielectric barrier discharge load and some considerations on power supply.(Kudryavtsev Oleg et. al.,1995)

For switching power supply design, proto-board testing is not sufficient to fully evaluate the EMC performance of the circuit, since the EMI problem is closely related to the PCB layout and routing of the circuit. To help circuit designers handle the design problem with ease, an integrated CAD tool was introduced in this paper which develops the PCB step by step via a modular approach. Particular emphasis is laid in the reduction of the interference between the noise-generating modules and susceptible modules. Moreover, some special features, such as auto-



routing and track angle smoothing, may help reduce the radiated EMI. Simulation based on SPICE provides useful information on the conducted EMI performance of the circuit, which allows the users to make a sensible choice on the input line filter or the PCB layout. Another feature that this CAD tool can provide is the performance index, which gives information to the users on how well the emission level of the PCB complies with specific EMC standards. This can help the designers pick the best choice among a number of possible designs.(Michael K. W. Wu et. al.,2001)

## **2.2 Summary of Literature Review**

For small low-power electronic circuits, the capacitive input power supply filter is popular. If load currents are not very large, the single capacitor may be an adequate filter. For larger load currents or when load voltage must be very stable, a voltage regulator may be used. For a fixed resistive load the circuit causes a constant current discharge of the capacitor, while the same load results in an exponential discharge in the circuit. The following analysis assists the designer in selecting the transformer, the diodes, and the capacitor.

The trend to pack more power in smaller spaces is leading to higher rates of computer power supply arcing in the field. Power density increase is being achieved by decreasing the spacing between features such as the power train MOSFET leads and by increasing the switching frequency. Both these changes make power supplies more prone to field arcing. This paper discloses a technique called the partial vacuum test to predict the arcing propensity in power supplies. The partial vacuum test also helps determine the corrective actions, needed to avoid field arcing, by indicating the locations susceptible to arcing. The paper also describes a test called the zinc spray test that can help determine the minimum spacing between features, subjected to high voltages with high frequency harmonics that will not arc in the field.

The reliable operation of computer facilities first of all depends from a level of characteristic of power supply systems. The essential advantages of switch power supply have spotted their using in this area of technique. The modern power supply should satisfy the following criteria ensure of functional parameters at activity of the disturbing factor, efficiency, reliability, mass and dimensions, cost. The specific requirements to the means of power supply of computer engineering depend on features of consumers and on the area of their use.

The requirements are high quality of output voltage, 100 % range of change of the load current, low level of electromagnetic interferences (EMI), high level of a dynamic parameters and high level of the load current. Besides, as a rule, for operation of computer means several levels of voltages with different levels of load currents are necessary. The used now methods of SMPS designing not always ensure an optimum combination of their performances according to the above-stated criteria and requirements.

This problem is possible for deciding with minimum costs, both on development, and at series production if to use pulse voltage regulators on the basis of so-called magnetic switches (MS). MS is a saturable core on the high-frequency amorphous material with RHL. These materials are based on cobalt (more than 80%). MS is used as a power regulated element.

## CHAPTER 3

### METHODOLOGY PROJECT

This paper presents about how to design a rectifier, a filter to remove ripple voltage from output, a regulator to regulate the voltage and backup for the power supply.

#### 3.1 Flow Diagram of the Proposed System

The operation of the system as shown in figure 3.1 . The proposed system consists of AC supply, uninterruptible power supply, rectifier, filter, and regulator.

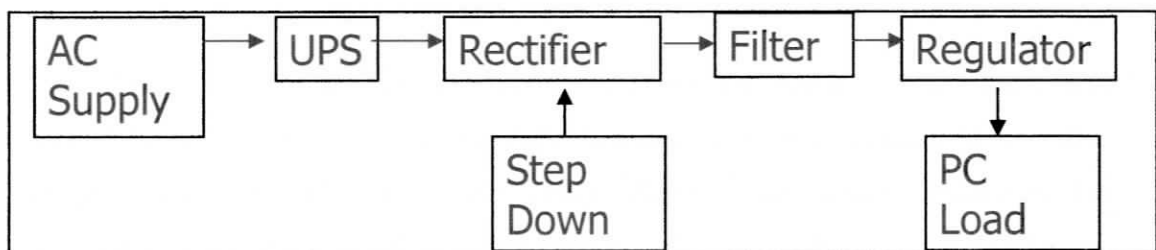


Figure 3.1: Flow Diagram of the System

The alternating current (AC) supply is come from utility. AC supply, supplied the uninterruptible power supply (UPS) to charge the battery in the UPS and supplied the power supply unit (PSU) for computer. In the PSU, rectifier circuit is used to converts an ac signal into a direct current (DC) signal and to step-down the input voltage of ac supply from utility.

The output currents of the rectifier circuit have harmonics because of the rectification process. The filter circuit is used to filter out some of the harmonics from the output signal of rectifier circuit. Lastly, the regulator converts a dc voltage normally unregulated to a regulated dc output voltage to the computer.

### **3.2 Rectifier**

A rectifier is an electrical device, comprising one or more diodes arranged for converting alternating current (AC) to direct current (DC). When just one diode is used to rectify AC (by blocking the negative or positive portion of the waveform) the difference between the term diode and the term rectifier is merely one of usage in example the term rectifier describes a diode that is being used to convert AC to DC. Almost all rectifiers comprise a number of diodes in a specific arrangement for more efficiently converting AC to DC than is possible with just a single diode.

The design of rectifier involves determining the ratings of semiconductor diodes. The ratings of diodes are normally specified in terms of average current, rms current peak current and peak inverse voltage. There are no standard procedures for the design, but it is required to determine the shapes of the diode currents and voltages.



### 3.2.1 Full wave rectifier

A full wave rectifier converts the whole of the input waveform to one of constant polarity (positive or negative) at its output by reversing the negative (or positive) portions of the alternating current waveform. The positive (negative) portions thus combine with the reversed negative (positive) portions to produce an entirely positive (negative) voltage/current waveform.

For single phase AC, if the AC is center-tapped, then two diodes back-to-back (in example anodes-to-anode or cathode-to-cathode) form a full wave rectifier. If there is no center tap, then four diodes, arranged in a bridge, are needed.

For three phases AC, six diodes are used. Typically there are three pairs of diodes, each pair, though, is not the same kind of double diode that would be used for a full wave single phase rectifier. Instead the pairs are in series (anode to cathode). Typically, commercially available double diodes have four terminals so the user can configure them as single phase split supply use, for half a bridge, or for three phase use.

A full-wave rectifier is usually used and the downstream inverter stage is simply designed to be flexible enough to accept the wide range of dc voltages that will be produced by the rectifier stage. As its title implies, a half wave rectifier allows only one half of the input waveform to reach the output. This may be the positive or the negative half depending on the sense in which the diode is connected. Half wave rectification can be achieved by a single diode in a one phase supply.

We also can do the calculation to design the rectifier. The equation to design rectifier is: