

Stable Fine Tuned Wide Range Variable Power Supply for Health Care Application

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Abstract— In this work, development of 12v DC power supply focused for biomedical purposes has been employed. The power supply is fully acquainted with a variety of combinations, and its creator should be able to choose the most suited for a given application because they have access to some quite potent design tools. The stabilized voltage supply, also known as the regulated power supply, is a crucial component that can deliver either direct current (DC) or alternating current (AC) to a variety of electronic devices. The majority of electronic instruments and equipment can currently use it. In order to get the machinery to operate normally, we must use the electric power stabilized electricity it offered. The effective voltage and frequency of the AC electricity network are 220V and 50Hz, respectively. To transform the electricity into steady direct voltage with particular amplitude that can be applied to all types of home appliances, we must utilize a regulated power supply. The majority of electronic instruments and equipment can currently use it. In order to get the machinery to operate normally, we must use the electric power stabilized electricity it offered. The effective voltage and frequency of the AC electricity network are 220V and 50Hz, respectively. To transform the electricity into steady direct voltage with particular amplitude that can be applied to all types of home appliances, we must utilize a regulated power supply. Thus, according to the results current flow of 220- 240 volt can be converted along with soft starting operations with adjustable range of constant voltage values. Advanced switching mode can be pertained with excellent design, small voltage and long term operation.

Keywords — 12v DC, biomedical, power supply, small voltage, soft starting, long term.

I. INTRODUCTION

Due to their comparatively high efficiency and small size, switch mode integrators are employed in place of linear voltage regulators at relatively high output levels. The shortcomings of linear regulators are

overcome by switch-mode regulators. They are more effective and frequently achieve efficiencies of 80% or higher. Moreover, they can be manufactured in a smaller size than linear regulators [1]. The stabilized voltage supply, often known as the regulated power supply, is a tool that can power a variety of loads. It can be split into the AC stabilized voltage supply and the DC stabilized voltage supply depending on the different types of electric energy output. Only the power supply for DC is covered in this work. [2-3] The primary purpose of a DC power supply is to maintain a constant voltage on its direct current side regardless of changes in the load or the AC input voltage. The accuracy, stability, and durability of the system are now required to be greater for electronic equipment, and the accuracy and dependability of a DC stabilized voltage power supply are also expected to be higher. The DC stabilized power supply can really be separated into in the series type and also the switch mode variety based on various circuit topologies. The switch mode power source is frequently used due to its compact size and excellent efficiency. The series DC stabilized voltage supply has limited capability and a large volume, and is typically utilized in situations with modest requirements for power efficiency and volume.

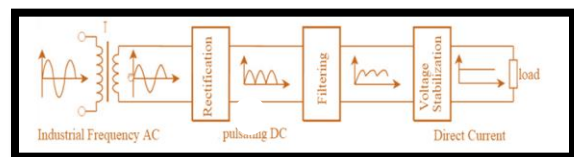


Figure 1: Standard Voltage regulated power supply
Figure 1 displays the schematic for the inverter circuit DC stabilized voltage supply. The switching DC stabilized voltage supply can be broken down into four modules for various purposes: conversion, rectification, filtering, and voltage stability.

The power transformer among them primarily serves two purposes. The first step is to boost or reduce voltage to transform 220V AC into AC voltage that complies with design criteria (usually reducing voltage). [4] The second is to use the transformer's magnetic coupling mode to isolate the AC current from following circuits, improving the stability of the stabilized voltage source. With the unilateral conductivity of the diode, the rectifier's primary job is to convert the industrial frequency switching power signal into a fluctuating DC voltage signal. The rectifying circuit is the primary target of the filter circuit. The rectifier circuit's output, a DC quantity with 100Hz fluctuation, has a significant impact on the power supply's output. The purpose of the matched filter is to smooth out the DC power at the leading end of the voltage stabilizing circuit by filtering the alternate component in the changing DC amount.

The main component of the stabilized DC voltage supply is the voltage stabilizing circuit, which is also challenging to control. No matter how the load varies or the frequency or amplitude of the AC input as well as output voltage changes, its primary job is to keep the DC voltage within the pre-set range. Currently, a controlled power supply is a crucial tool for investigations in electrical laboratories. Additionally, the regulated DC voltage must be able to offer constantly changeable voltage and have the features of displaying, alarming, over-current protection, over-voltage protection, and low voltage protection.

The goal of the effort was to produce a useful design for a 6kW DC power supply that is variable. The three power conversion steps were the foundation of the design's philosophy. The first stage involved stepping down the 3 phase main supply to 415V to 60V at 50Hz, and the 60V was then rectified using a three phase bridge converter and smoothing filter. Applying a dc-to-dc converter to the smoothed voltage at the end. A buck converter or step-down converter is used by a dc-to-dc converter to regulate the dc input voltage and generate a controlled dc output voltage. IGBTs and MOSFETs are the major electronics utilized for dc-to-dc conversion today.

A theoretical design as well as a simulation result using PSpice was provided in a previous publication [13], whereas this paper serves as a complement to that

one by presenting the hardware architecture and experimental findings.

II. REALIZATION OF REGULATED POWER SUPPLY

The procedure of changing voltage results in the realization of a DC controlled power supply. The circuit diagram of a DC controlled power supply is nicely displayed in Figure 1. Hardware design can essentially be used to realize the first three components of the schematic transformation, rectification, and filtering. The parameters of connected devices can be calculated in this section as long as the voltage, power, and other characteristics of the power source that is regulated have been established. The system's complexity has a role in voltage stabilization.

The closed-loop control method is typically used when designing the voltage stabilization component in order to prevent changes in load or changes in AC input voltage from having an impact on the output voltage. The output voltage is used as the controlled variable, and the actual and set voltage values are compared. The voltage stability can then be achieved using a certain regulating technique. There are currently two major ways to carry out the regulatory process.

One example is the implementation of a certain voltage stabilizing function, which is typically utilized in low-power applications, using a specialized semiconductor.

The voltage output can be made stable in the alternative scenario by employing a digital controller and coding. The voltage regulation of big and medium power equipment is where this technology excels.

Here are descriptions of the control modes [5].

A. Voltage Stabilizing Mode Controlled by a special Chip

Strong closed-loop control features are included into the unique empty box chips in this control mode. The constancy of the DC voltage that is generated can be achieved by managing in an on of the switches in the circuit by contrasting the gathering data and the required voltage value. Next, we'll use the BOOST

circuit, which the UC3842 chip controls, as an illustration to describe this control strategy.

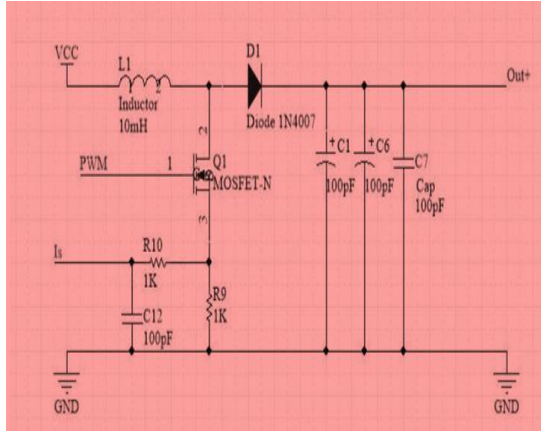


Figure 2: Boost Main Circuit

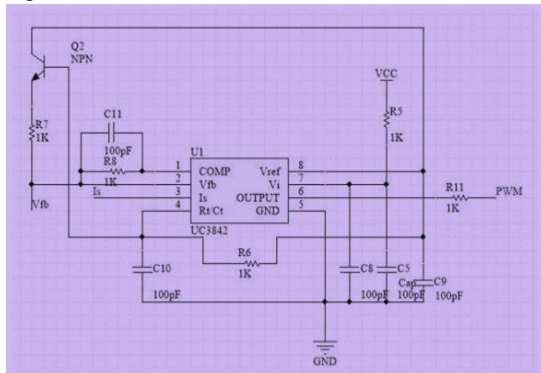


Figure 3: The drive Circuit

The UC3842 is a great control chip in the current mode. The chip has direct access to drive MOS transistors. With only 8 pins, the UC3842 chip's peripheral circuit is straightforward.

The UC3842 chip also exhibits good voltage regulation properties. It can regulate voltage at a rate of up to 0.01%. The oscillator, high gain error amplification with temperature controller, present monitoring and comparison unit, current of totem pole, input and reference under voltage locking circuit, and PWM latch circuit are also included into the chip. [6]

The figure displays the drive control circuit based on UC3842 and the BOOST boosting circuit, where Vfb is the output voltage post resistance voltage division feedback voltage. Two closed loops make up the majority of the circuit's voltage stabilizing mechanism. In closed loop one, the error amplifier on the UC3845 chip receives the feedback voltage and compares it to the reference value of 2.5V to produce the error voltage signal. The output voltage change

brought on by the change in load is the major target of the closed-loop. The main circuit's R9 serves as the current detecting resistance in closed loop two. When Q1 is turned on, a route is created by the inductance and R9.

B. Digital Controller Controls the Voltage Stabilizing Mode

Typically, a programmable chip is used to actualize the digital controller. MSP430 and DSP chips were currently in widespread use. The chip utilised in this type of power supply typically has or expands on A/D transformation functionality. The control chip periodically reads the current capacity voltage value through A/D to manage the power supply, and then compares it to the pre-set number in the programmer. The switching frequency or frequency of the switch tube's PWM signal can be controlled using PI adjustment or other means of adjustment, and the output power can be stabilized through dynamic adjustment.

C. Soft Start

One of the oldest technologies that can be used to motor control is soft start technology. In this form of control, the output voltage can be changed to indirectly regulate the output current. The stepped voltage is established during motor startup, and then, using this stepped voltage, the output voltage is gradually increased from nought to the rated voltage. This technique makes it possible to effectively control impulse current. Moreover, the beginning current can be changed to suit the real requirements. [7]

D. Protection function of soft start

The stabilized power supply must be capable of producing soft start and prevent surge current, but the soft start device must additionally have the ability to protect itself under unusual circumstances. To begin with, overload protection is required. All of the circuits are operating normally at their rated conditions, and the current flowing is also operating normally. The input current will, however, exceed the rated current or even the maximum preset setting of the input current when the load on the regulated power supply is too high. Hence, in this scenario, the regulated power supply's management system must quickly disable the PWM pulse signal to safeguard the switching devices. [8]

III. METHODOLOGY

The workflow design of regulated power supply with soft start function has been deployed in figure 4.

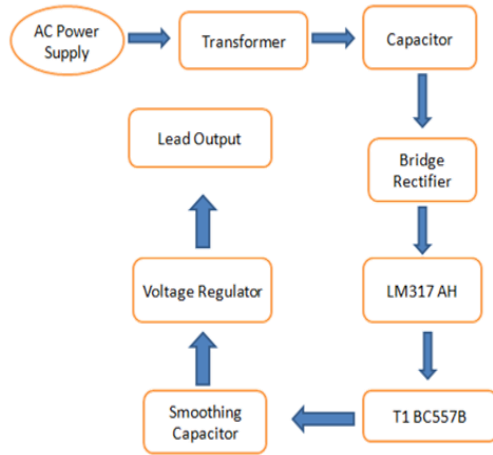


Figure 4: Methodology

In figure 4:

- The bridge rectifier uses the voltage from step-down transformer to produce a continuously pulsing DC signal.
- Unwanted current is eliminated with a smooth capacitor. The voltage regulator is provided a smooth DC signal.
- The ripples are removed using the capacitors.
- A voltage regulator's adjust pin is bypassed by the capacitor C3
- To safeguard the regulator, diodes are utilized.
- The adjacent pin of regulator is linked to a variable resistance device.

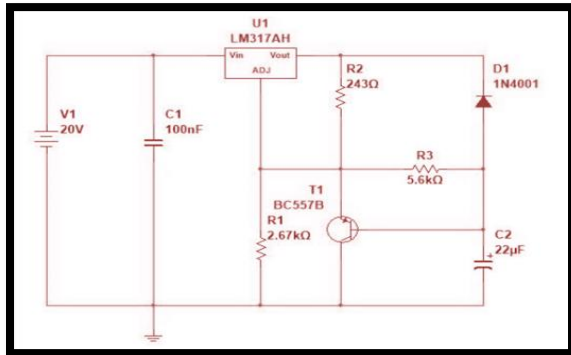


Figure 5: Voltage Stabilizing Circuit

Figure 5 depicts the voltage stabilizing circuit with soft start functionality. The voltage regulator in the circuit is an LM317AH chip, which can gradually raise the output voltage of the regulated power source from

1.25V to 15V after 3 seconds. 41.25 volts is the maximum input voltage. The obstacles R1 and R - square are a component of IC1's typical application (LM317). The output voltage has been set to U0. But, as C2 charges, R1 is shifted by T1, lowering the output voltage. [7] No voltage is present in C2 whenever the power is turned on. T1 is linked to C2 and powered by C2. The shunt effect of T1 gradually weakens as the voltage rises at both sides of C2, which causes the output voltage to rise over time.

The output voltage approaches its typical value when T1 is up. [9]

If the three second start time is too long, the value of C2 can be decreased. If more time is required, the quantity of R3 can be suitably raised. The experiment, however, indicates that the quantity of R3 can really be raised excessively.

Diode D1 is included in the design to provide a fast discharge channel for capacitor C2 in order to guarantee the capacitor's quick discharge so when power is cut off.

According to the simulation results, the minimum and maximum input voltages are 18 V and 41.25 V, respectively. The output current of the LM317 can exceed 1.5A when a heat sink is attached, and it has short-circuited protection. [10]

Figure 6 depicts the initial hardware development kit.

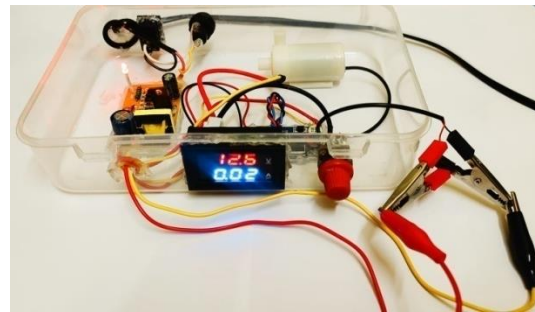


Figure 6: Initial Hardware Development Test Circuit

IV. RESULTS AND DISCUSSIONS

A. After changing the output current, measurement of the output voltage –

Current	0	0.1	0.2	0.3	0.4	0.5
Voltage	15.3	14.1	13.3	12.7	12.7	11.9
	1	2	3	1	4	2

Table 1 : After changing the output current, measuring the output voltage

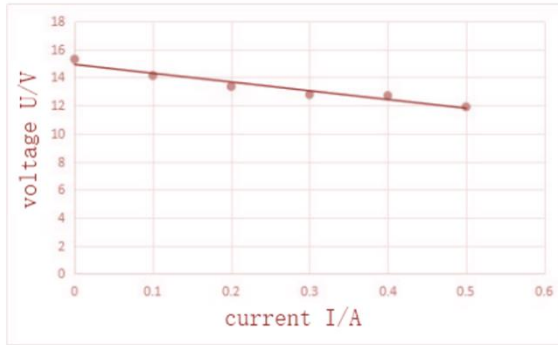


Figure 7: Voltage vs. Current graph with respect to table 1

The experimental results demonstrate that the voltage stabilizing power supply function of the experimental design has been accomplished, although there is a drawback. The voltage stabilizing effect diminished as the current increased progressively. The voltage falls to 11.9V when the current reaches 0.5A.

B. After changing the input voltage, measurement of the output voltage –

Voltage U1/V	15	16	17	18	20	25
Voltage U2/V	13.2	13.2	13.3	13.4	13.4	13.4
	2	4	1	0	2	5

Table 2: After changing the input voltage, measurement of the output voltage

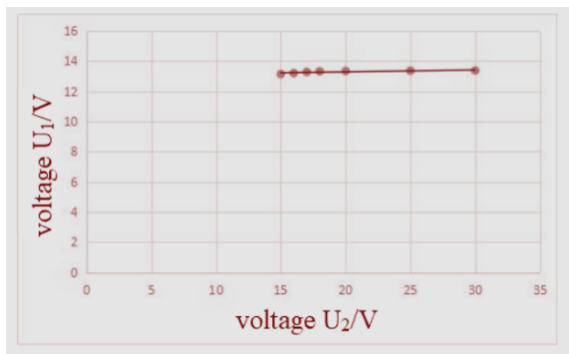


Figure 8: Voltage vs. Current graph with respect to table 2

It is clear from the statistics above that this design fulfils the role of a stable power source. We can clearly see the experimental findings from the data. Only a 0.23V change in the output voltage results from a 15V

change in the input voltage. Voltage stabilisation serves its purpose. [11]

C. Soft Start testing and problem fixing

Time T/S	1.0	2.0	3.0	4.0	5.0	6.0
Voltage U/V	4.2	8.6	15.2	15.6	15.8	15.9

Table 3: Soft Start testing and problem fixing

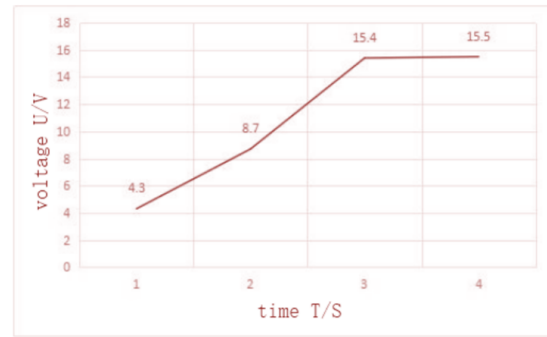


Figure 9: Voltage vs. Current graph with respect to table 3

According to the analysis, the test and the real object essentially satisfy the requirements of a soft start, and after approximately three seconds, the stable voltage is 15V..

VII. CONCLUSION

From this work, it can be concluded that constant values and voltages can be adjusted along with better reliability and smart effective control.

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