

Construction of High Precision AC-DC Power Supply



Akinpelu A., Usikalu M. R., Onumojor C. A.

Abstract. Several accessible power supply equipment with different difficulty levels and complexity mostly give a singular DC output that does not provide same use when an Output AC Power that is quite low to a great extent preferred. In this work, a stabilize, fixed and varying power supply device that has output voltage of 0.5 V to 18.15 V variable DC, and current range from 0 - 0.88 A with short circuit protection was constructed by using inexpensive materials, and fuse was used as circuit breaker . Likewise, we examined the regulation attributes of the power supply units that is just been constructed to a specific load regulation to decide its strength by contrasting it with a regular power supply device and ascertain the power supply's effectiveness through its efficiency. Test and examination were carried out utilizing the developed power supply unit to power loads of 10 to 50 Ω. The trend of the output results demonstrated that the power supply was in line with the standard PSU. The output supplied would be useful in research facility estimation to supply the power for direct incorporated circuits, delicate circuits, simple and advanced circuits, TTL and wide-ranging applications necessitating supply force.

Keywords—Efficiency, Power Supply, Load Regulation, Voltage.

I. INTRODUCTION

With the swift improvement in information science technology, power supply becomes more and more important. Especially low voltage stabilized power supply which is more popular in intelligent instruments and also in more extensive application and in low voltage stabilizing circuit which is in vogue today. So the research and design of adjustable power supply technology, become the focus again [1, 2]. A power supply is an electrical gadget that provides electricity for powering electrical appliance. The essential purpose of a power supply is to change lower voltage alternating current electrical power to high direct voltage utilizing the combination of capacitors and diodes consolidated into a system convert electric flow from a source to the right electricity needed to power a load [3].

Subsequently, electrical power converters are sometimes referred to as power supplies. Most power supplies are built into electrical equipment while others are stand alone. for instances, desktop computers have in built power supply and some electrical appliances used at homes. Restricting the current drawn by loads to safe levels is another purpose power supply serves, closing off the flow in case of an electrical fault, control molding to forestall electronic noise, power control factor rectification. [4].

A. Components of power supply

Power supply comprise of four basic components: transformer, rectifier, filter and voltage regulator. A transformer controls the incoming voltage by stepping it up or stepping it down. A filter smoothens out the dc (direct current) coming from a rectifier. A rectifier converts ac (alternating current) into dc. A voltage regulator controls the dc output, allowing the correct amount of power, volts or watts, to be supplied to the computer hardware. A sinusoidal wave form will be taken by alternating current with the voltage changing from positive to negative in periods of time [6].

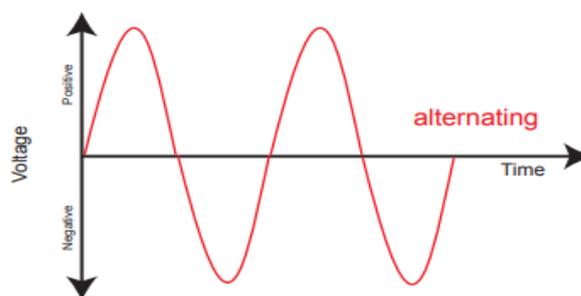


Figure 1: Alternating current from wall outlet [7]

In the initial step of the procedure, the voltage is rectified utilizing a lot of diodes which performs bridge rectification. Sine waves are been converted to possible peaks by rectifier. When rectification has taken place, there is still instability in the waveform. A capacitor then smoothens the rectified alternating current voltage via a capacitor [8]. The capacitor used must be very big and makes a repository of energy that is connected to the load when there is reduction in the rectified voltage. Then the new energy is stockpiled in the capacitor on the rising edge and used when the voltage falls. This fundamentally lessens the measure of voltage drop and smoothens out the voltage. Expanding the capacity limit of the capacitor for the most part creates a higher quality power supply [7, 11]. The source of energy for DC power supplies are AC mains power. Such power supplies employ a transformer to adjust input voltage to recommended alternating current voltage.

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Rectification is done by using rectifier to switch the transformer output voltage to a variable Direct Current voltage, which thus is gone through an electronic channel to switch it to an uncontrolled Direct Current voltage. The filter ejects most, nevertheless not the all of the Alternating Current voltage varieties; the rest of the Alternating current voltage called swell.

The load's resilience of swell guides the standard of filtering that a power supply supplies. Talking about most applications, high ripple is tolerated and afterwards no separation is required. For instance, in some battery charging devices, it is conceivable to execute a mains-controlled DC power supply with just a transformer and a solitary rectifier diode, with a resistor in arrangement with the yield to constrain charging current [1 - 4].

B. Load regulation

This is the capability of a power supply to sustain a steady voltage (or current) level on the output control of a power supply regardless of changes in the supply's load [9- 13].

$$\% \text{ Load Regulation} = \frac{V(\text{No load}) - V(\text{fullload})}{V(\text{fullload})} \times 100 \text{ --- (1)}$$

V(No load) is load voltage with no load current, V(Full Load) is Load voltage with full load current

II. MATERIALS AND METHOD

Figure 2 is the circuit diagram used for the construction of the power supply. Analysis of the different stages that make up a power supply, makes one understand the device. The phases are the unregulated, the regulated, the gain control, the current amplifier, and the current limiter [23-25]

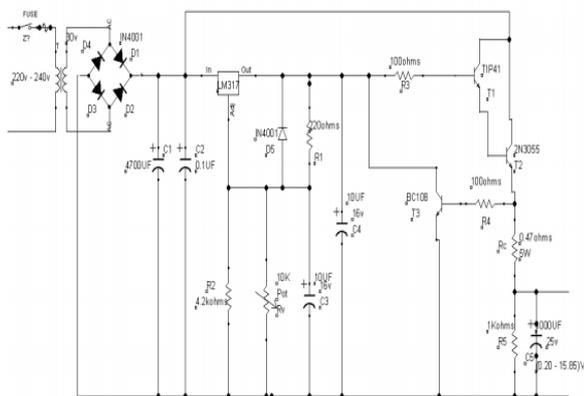


Fig 2: circuit diagram of the design

A. Overload Regulation

Power supplies frequently have immunity from shock that could harm the supply. The two generally utilized systems for over-burden assurance are fuses or circuit breakers. In this work, a fuse was utilized. A fuse contains a short bit of wire which melts if an excess of current streams. This viably detaches the power supply from its load, and the device quits working until the issue that caused the over-load is removed and the wire is planted and fuse is made. Fuses in power supply units might be replaceable by the owners, yet in compacted electronic equipment, tools are required before one can get access to the fuse. [11 - 15].

B. Efficiency calculations for power supply

The efficiency of a power supply (AC-DC) can gotten by finding the ration of its input power to its output power. More accurately, efficiency of the power supply is calculated by dividing the output power (Pout) by its input power (Pin). It can be calculated using equation 2 [18 - 23]

$$\eta = \frac{P_{out}}{P_{in}}$$

Table 1: Indicates voltage and current at different conditions

Voltage and Current at different conditions	
Full Voltage	
(No Load)	8.15V
Least Voltage	
(No Load)	.50V
Voltage (Full Load)	
Output	5.11V
Current(No Load)	.88A
INPUT	
POWER	5.97W

Table 2 expresses the average values of voltage and current across the power supply

Load (Ω)	Voltage (V)	Current (A)	Power Output(W)
10	8.67	0.74	6.38
15	9.99	0.66	6.54
20	11.16	0.61	6.79
22	11.88	0.58	6.87
25	12.2	0.55	6.71
30	12.71	0.51	6.46
35	13.11	0.47	6.22
40	13.7	0.45	6.14
45	14.3	0.41	5.8
50	15.11	0.32	4.77

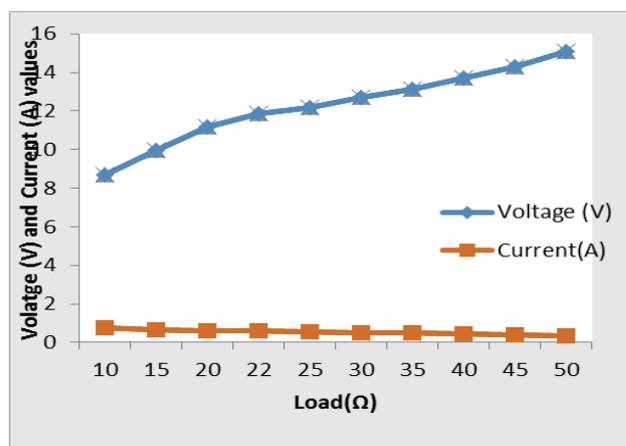


Fig 3: Variation of average voltage and average current with load

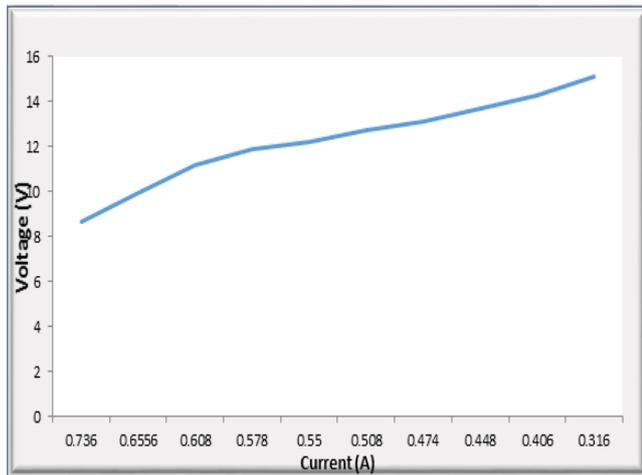


Fig.1 4: Plot of voltage against current

Figure 3 showed that as the load was increasing, the output voltage of the power supply increased, while the output current uniformly decreased with the commensurate values of the load. The average power output was found to be 4.18 W. By comparison, Figure 4 follow the standard pattern of factory produced power supply and their regulation characteristics is equally the same. This connotes that the necessary requirements of a standard power supply device was met by the built steady adjustable PSU [24]. The efficiency of the power supply is found to be 26.19%. The load regulation was found to be 0.20 %. The power supply is relatively good since the smaller the load regulation, the better the power supply.

III. CONCLUSION

A stable power supply device with output voltage going from 0.50 V – 18.50 V, a yield current spanning of 0 – 3A, power of 45W, with power conversion efficiency of 26.19% and load regulation of 0.20% was fabricated and effectively built. The research was developed utilizing materials that are moderately inexpensive once contrasted with customary device of a similar yield variety in the marketplace. It has been tried and it met the necessary pre-requisites according to ref 24, for a standard PSU which can be used in labs. For future work, we prescribe that there can be increment in the current range.

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