Construction of High Precision AC-DC Power Supply

Akinpelu A., Usikalu M. R., Onumejor 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].

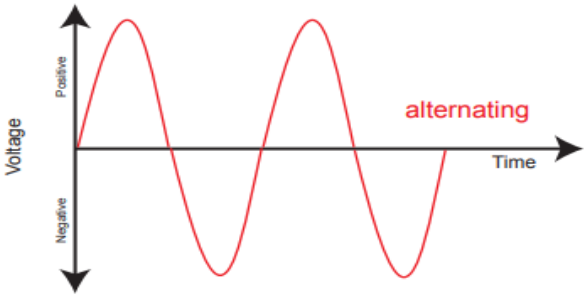

Figure 1: Alternating current from wall outlet [7]

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. 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.

Revised Manuscript Received on March 15, 2020.
Akinpelu A., Department of Physics, Covenant University, Ota Nigeria.
Usikalu M. R., Department of Physics, Covenant University, Ota Nigeria.
Onumejor C. A., Department of Physics, Covenant University, Ota Nigeria.

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].

$$\%Load\ Regulation = \frac{V(Noload) - V(fullload)}{Vfullload} \times 100 ----(1)$$

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]

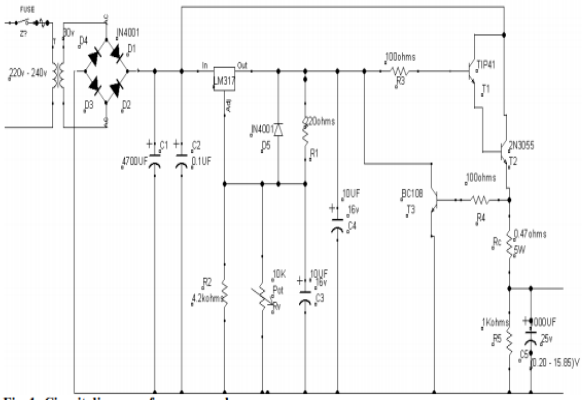

Fig 2: circuit diagram of the design

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]

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

Device testing and analysis n

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)	5.11V
Output 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

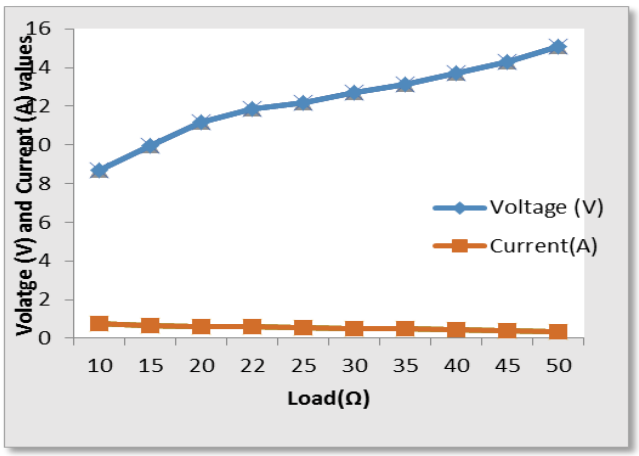

Fig 3: Variation of average voltage and average current with load

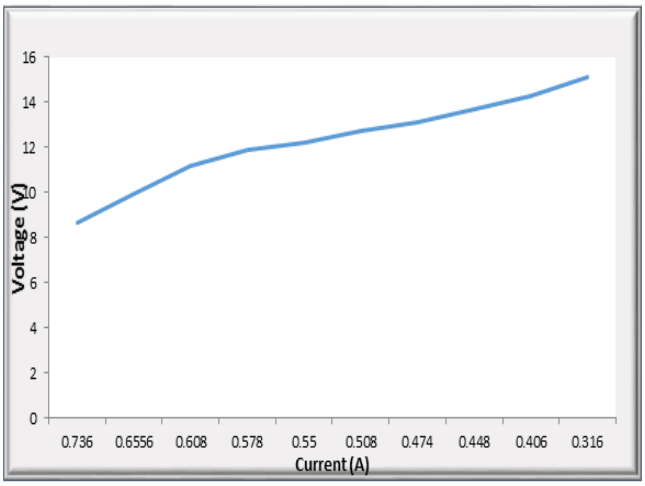

Fig.1 4: Plot of voltage against current

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.

ACKNOWLEDGMENT

The authors will like to appreciate Covenant University for this publication support.

REFERENCES

1. Adelakun Adedayo Oke, Rabiu Jamiu.Ariyo, Egunjobi Abiodun Isiaka, and Akinnubi Rufus Timotheu. 2014 "Design and Construction of a Stabilize Variable Power Supply Unit" Innovative Systems Design and Engineering. (5), pp. 6
2. Adejumobi I. A., Olanipekun A. J., Adebisi O. I. & Adeomi A. A.,2012 "Development of A Multi Ac/Dc Power Supply System For Domestic And Laboratory Use"(12) pp. 12
3. Garba Babaji. "Design and Construction of A 12 KV D.C. Power Supply" Bayero Journal of Pure and Applied Sciences, (2) pp. 175 – 184.
4. Manisha Ghodkea, Sujata Naduvinamani, Anusha Kanchagar, Chaitrapatil and Akshata Miskin. "design and development of stabilized regulated fixed and variable dc power supply unit (psu) with short circuit protection" 2015 Proceeding of NCRIET-2015 & Indian J.Sci.Res. (12):267-272.
5. Adejumobi I. A., Olanipekun A. J., Adebisi O. I. & Adeomi A. A.,2012 "Development Of A Multi Ac/Dc Power Supply System for Domestic And Laboratory Use" Ijrras (12), pp. 12.
6. Jangfa T. Zhimwang, Yunisa Yahaya, Ibrahim Aminu, E. M. Fomson, and Dachomo D.B. Design and Construction of a Dual Regulated ±0-35volts Dc Power Supply Using Lm317 And Lm337 Voltage Regulator. African Journal of Natural Sciences 20. Pp107-118
7. Aktan O., Sariolu B., Cindemir U., Onur Unlu S., Dunder G., Mutlu S.,
8. Yalcinkaya A. D, 201: Cmos Power Supply Unit for Electrically Isolated Micro Scale Application. www.iiste.com 747-756
9. R. Visintini Elettra Synchrotron Light Laboratory, Trieste, Italy
10. 9. Coughlin. R. F. and Daiscod. F. F. 1992 Operational Amplifier and Linear Integrated Circuit (4th Edition) Prentile – Hall of Indian, Private Ltd. New Delhi – 110001.
11. Filtegerald A. E. Higginbotham. O. E and Grabel. L. A. M. (1988): Basic Electrical Engineering (5th Edition) Megraw-Hill Books Company, New York. 94
12. Fair Child Groups; 1967: Appliction Engineering Staff of the S. G. S. Industrial Circuit Handbook. Fair Child Publication.
13. G. L. Tater; 1976: The Mpc1000 – Super Regulator, Ham Radio, pp.52-54 Harrison G; 1975: Basic Electronics, Resistor in Circuit, Capacitor in Circuit. The English University Press Ltd Ibadan, Nigeria. 101
14. Horowitz. P. And Hill W; 1995: The Art of Electronics, Cambridge University Press, Campbridge.
15. Martin Hartley. J. 1990: A Practical Introduction to Electronic Circuits, Cambridge, University Press. Cambridge.
16. Morris. C. 1992: Electronic Circuit, Design And Application (2nd Edition) Mcmillian Education Limited, London.
17. Olson. H. 1973: Second Generation Ic Voltage Regulators; Ham-Radio Magazine. Subrahmanyam S. 1982: Experiment In Electronics Mcmillian Education, Toronto Canada.
18. Seigler D. P; 1973: A Basics Electronics Technology Bruce Co-Operation, Beverly Hills California.
19. Waterworth G.; 1988: Work Out Electronics. Mcmillian Education Limited, London.
20. Woolard B. 1984: Practical Electronics (2nd Edition) Megraw – Hill Books Company (Uk) and Cambridge University Press, Cambridgey
21. Ayara W. A, Omotosho T. V, Usikalu M. R, Singh M. S and Suparta W. (2017) Development of a solar charged laboratory bench power supply, Journal of Physics: Conference Series, 852(1): pp. 012044
22. Nwoye C. D., Usikalu M. R., Babarimisa I. O, Achuka J. A and Ayara W. A. (2017) Construction of An Automatic Power Switch using Infrared Motion Sensor, Journal of Informatics and Mathematical Sciences, 9(2): 331–337
23. Usikalu M. R, Shittu A. H and Obafemi L. N (2018) Construction of an intelligent and efficient light control system, International Journal of Mechanical and Production Engineering Research and Development (IJMPERD), 8(4): 1057-1066Aderhold J, Davydov V Yu, Fedler F, Klausing H, Mistele D, Rotter T, Semchinova O, Stemmer J and Graul J 2001 J. Cryst. Growth 222
24. Power Supply Safety Standards, Agencies, and Marks https://www.cui.com/catalog/resource/power-supply-safety-standards-agencies-and-marks.pdf

AUTHORS PROFILE

Akinpelu Akinwumi currently works at the Department of Physics, Covenant University Ota Ogun State, Nigeria. Akinwumi does research in Condensed Matter Physics, Biophysics, Physics electronics and Materials Science.

Usikalu M. R. My research area is Radiation and Health/ Medical Physics. Assessment of the effects of radio frequency radiation on biological materials. Measurement Environmental radioactivity in soil, water rock etc.

Onumejor C. A. has PhD in medical physics and does almost of her researches in Radiation and Health or Medical Physics, Radiation. Risk Assessment, Radiation Oncology e.t.c.