Low cost and Portable DC Regulated Power Supply for Experiments in Physics in School and College Laboratory

Rohan D. Lahane, Arvind Paranjpye
Nehru Planetarium, Dr. Annie Besant Road, Worli, Mumbai - 400 018, India.

Abstract: **In a laboratory, a DC power supply with fixed or variable voltage, is very essential for performing various experiments. To study the laws of electricity like Ohm's law or to perform the experiments in Optics, where a light source with variable intensity is required etc. power supply plays a vital role in achieving this requirement. This paper deals with an inexpensive and portable DC regulated and variable output power supply from any fixed input voltage DC power adaptor, developed at Science Laboratory, Nehru Planetarium (Mumbai).**

Keywords: **DC power supply, AC to DC battery eliminator, Power adaptor, LM 317, Bass-pot, Ohm's law, test circuit**

I. INTRODUCTION

Typical variable DC power supplies found in school laboratories are bulky in size and are expensive (Fig.1a).

Fig.1a: Variable DC power supply

Fig.1b: Battery eliminator

Normally, a DC power supply of a 0 to 12V or 0 to 30V with 1.5A current specification, housed inside a plastic case is used. Alternative device to avoid the expensive regular power supply may be the battery eliminator (Fig.1b). The major disadvantage of the battery eliminator is, they have fixed resistors that are capable only to provide fixed voltages. It lacks to provide any desired value of voltage within the voltage range. Also, there might be a possibility of current loading that in turn can harm the primary circuit connected to it. With the regular use of this power supply, there is a discrepancy observed in the output voltage and corresponding current, over the period of time. After which the power supply cannot be used to obtain the desired voltage and current requirement. Also, if any component is over heated by unstable input AC voltage and gets damage, that component cannot be removed or replaced with newer one, which is the important drawback of such power supply. Such power supplies are expensive.

For the above purpose, a low-cost and portable DC to DC power supply is presented and discussed in the paper, which can be used over a period time with same desired output voltage and corresponding output current. This power supply can replace the regular power supply and if any component gets damage, it can be easily replaced with new ones and the same power supply can be used over a longer period. Further it offers easy maintenance and servicing. The most important advantage is, this power supply can be used to vary and regulate desired voltage and corresponding current from any fixed DC voltage power adapter connected across it.

II. MATERIALS AND METHODS

The power supply is designed and developed in the laboratory, is made of plastic material casing with the dimension of 9 cm × 5 cm. Simple, cost effective and readily available components such as LM 317, resistor (220/270Ω), Bass Potentiometer (1 k Ω), a switch and banana sockets are used. The schematic and the actual power supply are shown in Fig.2a and Fig.2b respectively.

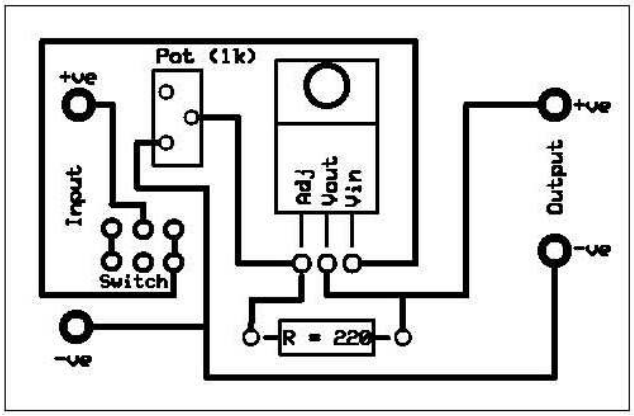

Fig.2a: Schematic

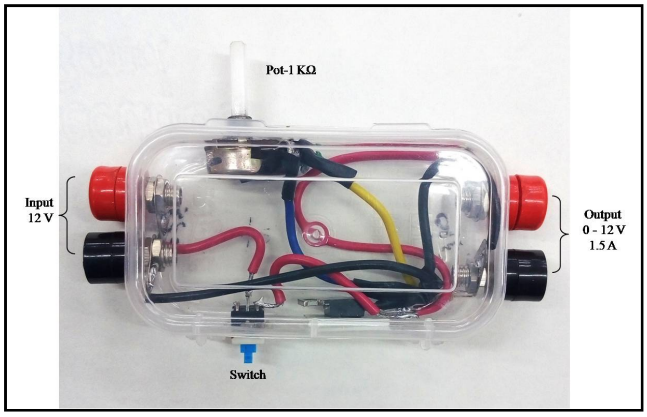

Fig.2b: Actual

The IC LM 317 is an adjustable 3-pin terminal positive voltage regulator. It is capable of supplying more than 1.5 A of load current over a range of adjustable output voltage between 1.2 V to 37 V. Another important aspect of this IC is, it eliminates the usage of fixed voltages, as seen in battery eliminator. Hence, we can get any voltage in a given voltage range. The pin-out diagram and the actual IC are shown in figure 3. A fixed resistor (220 Ω – 270 Ω), as shown in figure 4, is connected between adjustment and output pins of the LM 317. By doing so, the LM 317 serves as the precision current regulator.

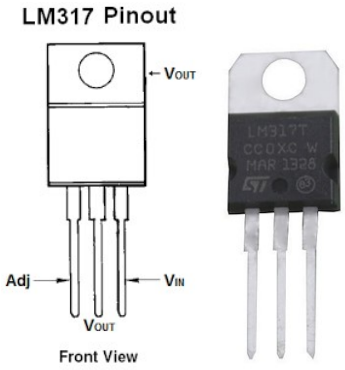

Fig.3: IC LM 317

Fig.4: Fixed resistor

Fig.5: Bass potentiometer

The desired output voltage within the given voltage range is precisely achieved by using the bass potentiometer (Fig. 5). A manual switch is connected between the input voltage terminal and the IC LM 317 for ON/OFF purpose.

III. RESULTS AND DISCUSSION

3.1 Laboratory test

The portable power supply was tested in a circuit consisting of an ammeter connected to the resistor of 470 Ω in series and the voltmeter connected across the resistor in parallel (Ohm's Law) (Fig.6a). For comparison purpose, the similar circuit was tested using regular power supply (Fig.6b).

Fig.6a: Test circuit using Portable power supply

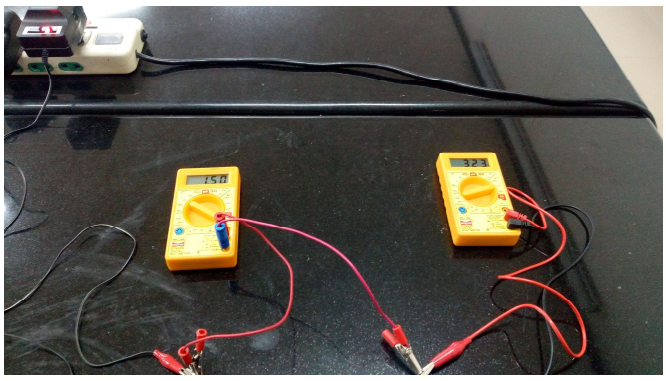

Fig.6b: Test circuit using regular power supply

To observe the current trend as the voltage is increased, the voltage across the resistor and corresponding current through the resistor was measured, for both the power supplies. The tables are shown below:

Test Circuit: Ohm's Law

Sr. No.	Applied Voltage (V)	Voltage across resistor (V)	Current measured through resistor (A)
1.	1.50	1.51 ± 0.01	3.24 ± 0.01
2.	3.00	2.78 ± 0.01	5.92 ± 0.01
3.	4.50	4.34 ± 0.01	9.35 ± 0.01
4.	6.00	5.56 ± 0.01	12.21 ± 0.01
5.	9.00	8.42 ± 0.01	18.64 ± 0.01

Table 1a: Voltage and current data measured using regular DC power supply (12V, 1.5A)

Sr. No.	Applied Voltage (V)	Voltage across resistor (V)	Current measured through resistor (A)
1.	1.50	1.48 ± 0.01	3.22 ± 0.01
2.	3.00	2.89 ± 0.01	6.16 ± 0.01
3.	4.50	4.33 ± 0.01	9.27 ± 0.01
4.	6.00	5.80 ± 0.01	12.37 ± 0.01
5.	9.00	8.70 ± 0.01	18.64 ± 0.01

Table 1b: Voltage and current data measured using Lab developed portable DC power supply 12V, 1.5A)

By comparing both the tables, the voltage across the resistor and corresponding current through the resistor was found to be in good agreement for both the power supplies.

3.2 AC-DC power adapter of fixed output voltage

Lab developed portable DC power supply connected to fixed voltage AC to DC adapter.

The portable power supply developed in the laboratory has an important aspect that any AC-DC power adapter can be connected to it. To verify this, a similar test circuit (mentioned above) was connected to an AC-DC power adapter of output voltage (4V, 800mA) as shown in figure 7 and the voltage across the resistor and corresponding current through the resistor was studied.

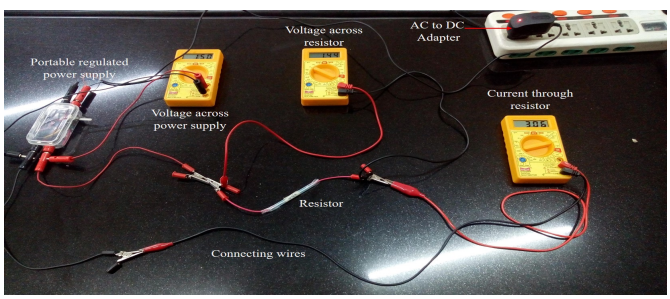

Fig.7: Test circuit using Portable power supply connected to AC to DC Adapter

Sr. No.	Applied Voltage (V)	Voltage across resistor (V)	Current measured through resistor (A)
1.	1.50	1.48 ± 0.01	3.22 ± 0.01
2.	2.00	1.93 ± 0.01	4.10 ± 0.01
3.	2.50	2.40 ± 0.01	2.12 ± 0.01
4.	3.00	2.90 ± 0.01	6.16 ± 0.01

Table 2: Voltage and current data measured using AC to DC adapter of any fixed output voltage

From above table it was verified that any AC to DC adapter of any fixed output voltage can be varied smoothly and precisely within its voltage range, by connecting it to the portable power supply.

IV. CONCLUSION

The new designed portable power supply has several important advantages over the regular power supply;

- Very cost effective and compact in size.
- It gives smooth and precise values of voltage for any AC-DC power adapter of fixed voltage within its range.
- All components can be replaced with newer ones. This offers easy maintenance and servicing of the power supply, and can be used over a longer period.
- Very useful for laboratory experiments in field of optics, electricity & magnetism etc.

ACKNOWLEDGEMENT

The authors are thankful to Ms. Bhagyashri Todankar and Ms. Shivani Agre for their valuable inputs during the development stages of the power supply. Also, we like to put on record the help and support readily provided by our colleagues at the centre.

REFERENCE

[1]. Data sheet of IC LM 317.