

Development of a High Voltage Variable Power Supply for Low-Power Appliances

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Abstract- The cost of electronic equipment falls down but the nuclear instruments remain costly. Under this consideration a Low-Power Variable High Voltage Power Supply has been designed using state-of-the-art technology. The design is essentially focused upon low power electric appliances such as GM detector, Scintillation detector, Camera flash light etc. In this design 6-volt DC battery is used as its input power supply. The designed power supply provides AC output voltage ranges from 450 volt to 2000 volt. It included the facilities for adjusting at any fixed value within the above-mentioned ranges. The power rating of the device is 1 W. The proposed system has been tested and found to be reliable and satisfactory results. The load regulation is 1.03% and maximum load tested for this device is 10M Ω . The designed technique is unique of its type, because the design is very simple and readily-available components are employed. The system should be beneficial in providing a portable and low-cost high voltage power supply.

Key Word — Low-power, Sign wave, Camera flash light, GM detector, High Voltage

Date of Submission: 02-12-2022

Date of Acceptance: 14-12-2022

I. INTRODUCTION

In this golden age of technological advancement, the need to design and develop power supply units in most developing countries of the world, like Bangladesh, has been on the increase and has remained one major area of an intense research. The electricity supply from the national grid is an alternating current (AC). At the consumers' end, after series of step-down processes, the walls' outlets carry a 50Hz, 220Vrms AC voltage supply. The energy from the wall outlet is practically limited; however, it must be converted from the alternating current (AC) to the direct current (DC) form and tailored towards providing the suitable levels of voltages for driving most electronic equipment. This can be achieved by using a DC power supply unit (PSU) [1,2]. The PSU is a device that supplies electrical power to a device or group of devices [1,3,4]. The PSU is most important factor in electronics life. Nothing being thinks without power supply [5,6]. A power supply unit is essential for the operation of the any electronic equipment and systems. Generally, a high voltage power supply consists of pulse generator, a driver and step-up transformer, rectifier, filter and control circuit for stabilization [4]. The high voltage (1000V AC) unit provides the biasing voltage to the GM detector Scintillation detector. Since the output pulse height of the detector depends on the energy of the radiation under measurement and also on the biasing voltage of the detector [7].

A high voltage unit was developed to operate the GM detectors [8]. This power supply unit gives the constant output for the variation of input voltage from 6 volt to 4.5 volt. The voltage adjusting is so difficult in this system. This system, however, is quite expensive and complex in design because it was transistor module.

The circuit complexity has been reduced using microcontroller. A microcontroller-based power supply is explained in S.M.S. Hossain et.al [9]. All function of the circuit is controlled by the microcontroller. In this design, they have used external comparator and external oscillator circuit.

Microcontroller based highly regulated power supply is explained in M.A.A. Mashud et.al [11]. It was implemented through a low-cost RISC microcontroller PIC12F675. Voltage regulation is one of the important features of the design that requires feedback loop for monitoring the output voltage, voltage regulation has also been addressed in the designed system. In this design external comparator and external oscillator circuit has been removed and used built-in comparator and built-in oscillator of the microcontroller. Therefore, the circuit design becomes comparatively small.

In the present time, we want to avoid the program design complexity using very simple circuit. Now we have proposed an attractive high voltage power supply. The proposed technique is unique of its type, because the design is very simple and readily-available components are employed. The system should be beneficial in providing a portable and low-cost high voltage power supply. The specifications of the proposed system parameters are given in Table 1.

Table 1: Specifications of the proposed system

Parameter	Specification
Power rating	1W
Input dc voltage	4.5 V DC
Output voltage (minimum)	450 V AC
Output voltage (maximum)	2000 V AC
Load regulation	1.03%
Maximum load (tested)	10 MΩ

II. SYSTEM DESIGN

The system is divided mainly into five parts, namely, Low Voltage Power Supply, the Indicator Circuit, Oscillator Circuit, Step-Up and Pulse Transformer and Voltage Doublers Circuit. The block diagram and the complete circuit diagram of the proposed system are depicted in Fig. 1 and Fig. 2 respectively.

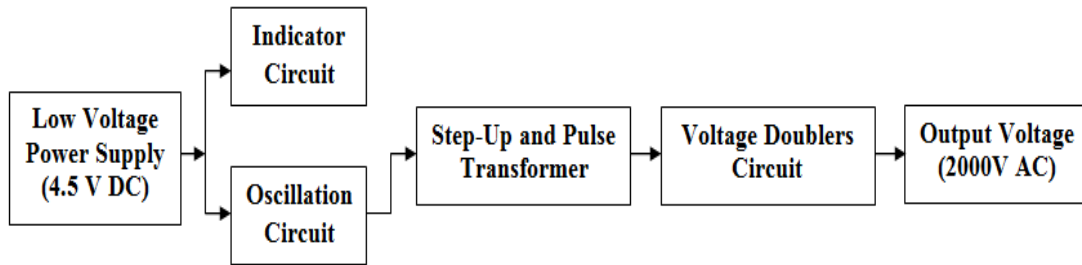


Fig.1 Simplified Block Diagram of the Proposed System

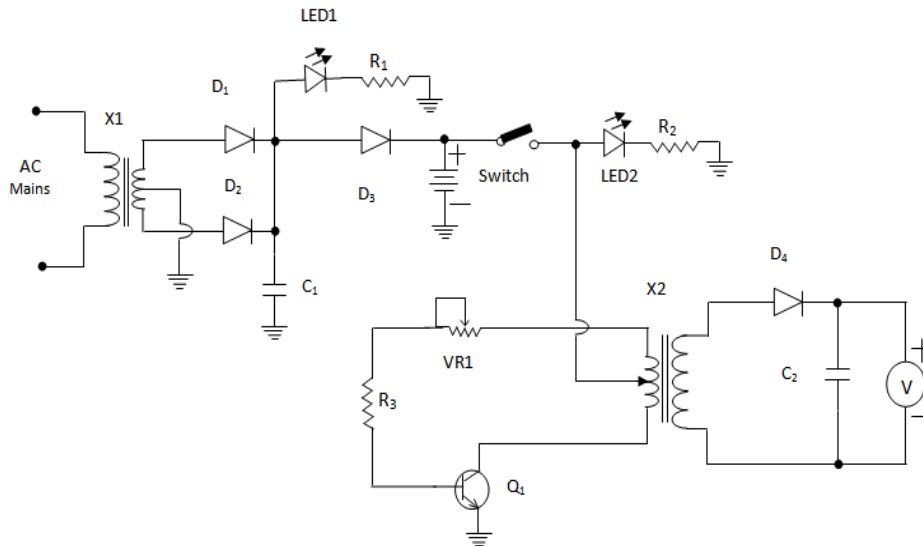


Fig.2 Circuit Diagram of the Proposed System

A. Low Voltage Power Supply

One 6 V dc rechargeable battery has been employed as a low voltage power supply in this design. This battery has been collected from local market.

B. Battery Charging Unit

The battery charging unit consists of a step-down transformer (X1), rectifier diode D₁- D₃ and capacitor C₁

C. *Indicator Unit*

Indicator unit is divided into two parts. One is battery charging indicator which consist of LED1 and resistor R₁. Another one is used for battery full charged indication which consists of LED2 and resistor R₂.

D. *Oscillator Circuit*

The oscillator circuit consists of a transistor Q₁, resistor R₃, variable resistor VR1 and primary section of the pulse transformer (X2)

E. *Step-Up and Pulse Transformer*

The driver and step-up transformer unit consists of ferrite core transformer (X1) with a coil of SWG 40. The output of the oscillator circuit is applied to the primary input of the pulse transformer. The output voltage of the transformer depends on the number of turns of the primary and secondary winding.

F. *Voltage Doublers Circuit*

The voltage doublers circuit consists of a diode D₄ and a capacitor C₂ [10]. This circuit develops two times of the peak input voltage [11].

III. RESULTS AND DISCUSSION

The variable regulated high voltage power supply for low power appliances has been designed and developed successfully and it shows good performance. We have employed locally available low-cost components in our design. So, the developed system becomes very simple and small in size. In the proposed system firstly, we have preciously designed and tested low voltage supply unit. We have varied the input supply AC voltage $\pm 10\%$ of 220 volt. We found this unit gives exactly 6-volt DC as shown in Fig. 3.

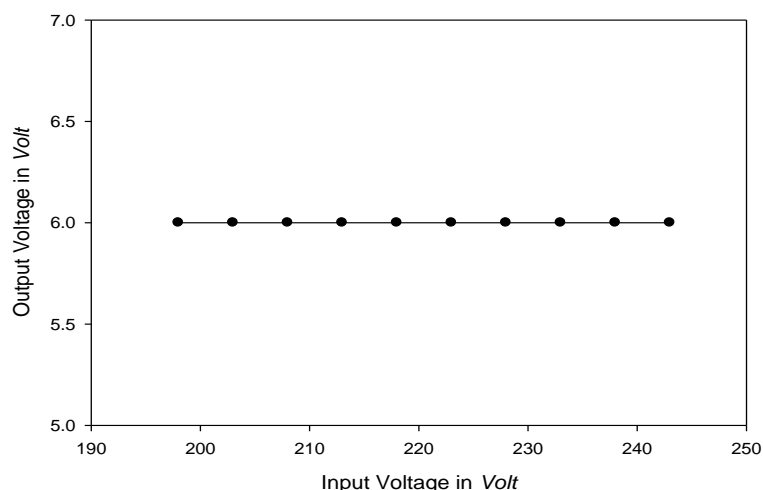


Fig. 3: Output of low voltage supply unit

We have ascertained the developed device in a series of test and we observed sound performance. We have recorded the numerical values of output voltages for different values of input voltages. The voltage regulation curve of the proposed high voltage power supply unit is shown in Fig. 4.

From Fig. 4, it is observed that the output voltage remains constant at +450V, 600V, 800V, 1200V, 1600V and 2000V dc for the input variation from 6 volt to 2.5 volt. Whereas, the presently used system gives the regulated output for the variation of input voltage from 6V to 4.5V which are used in Sensitive Radiation Survey Meter [12] and Portable Radiation Survey Meter [13].

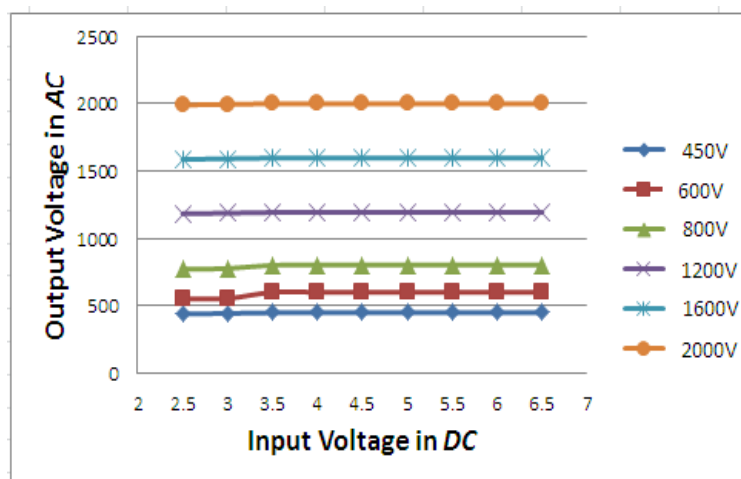


Fig. 4: Output Voltage Regulation Curve

The locally available high voltage power supply unit uses a large number of components so the circuit design is very complex. Some design systems use microcontroller which is programmable. Though reduces the circuit design in this system but the programming is complex and time consumed. To overcome all complexity, we have proposed a very simple circuit for high voltage power supply which may be acceptable in worldwide for circuit designer and scientist. The locally available high voltage power supply is compared with the proposed system in terms of features, voltage regulation, battery backup time and price. The comparisons are listed in Table 2.

Table 2: Comparison of the locally available high voltage power supply with the proposed power supply

	High voltage power supply [7]	High voltage power supply [11]	Proposed System
Voltage regulation	1.04%	0.83%	0.93%
Module	Transistor	Microcontroller	Pulse Transformer
Input voltage variation	6 volt to 4.5 volt	6 volt to 3.2 volt	6 volt to 3 volt
Battery life time for continuous use	Approx. 150 hours	Approx. 220 hours	More than 250 hours
Price (US\$)	20	12	10

It can be seen from Table 2 that the proposed system has very good voltage regulation. The battery back-up time of our proposed system is more than 250 hours for the continuous work, whereas the battery back-up time of the presently used system is about 150 hours. Therefore, the proposed system is better than the presently used system. The cost of the system which is significantly lower to other systems with similar features is another advantage of this system.

IV. CONCLUSION

Now-a-days the cost of electronic equipment fall down but the nuclear instruments remain costly. Also the backup time of locally available high voltage power supply unit is low. Under those considerations we have presented that the proposed system is of low cost, high backup time and high accuracy. The proposed system has been tested and found to be reliable and satisfactory results. Besides, a comparison on the features of different types of high voltage power supply has been presented. It shows that the proposed system is of better choice in terms of cost, backup time, portability and design.

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