

DEVELOPMENT OF WORKBENCH POWER SUPPLY WITH CURRENT LIMITING FOR LEARNING TOOLS

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ABSTRACT

Learning is a process of enhancing new knowledge and skills that can be applied in daily routine as human learning starts. The learning process for the technical students starts in involving the interfacing with machines and equipment. The most common equipment for technical courses involved the usage of power supply. There are some procedures in operating the device. One should be equipped with a broad knowledge in handling the power supply. Thus, the project is focusing in developing a workbench power supply, which is aimed to contribute as a teaching tool to the technical students and program. In developing the workbench power supply, the common component used are rectifier, capacitor filter, regulator, and buck converter. It is also including the simulation design the power supply circuit using Proteus and Fritzing. The objective of the project is aimed to introduce a basic electronic equipment bench power supply is a standard piece of test and measurement equipment on every electrical engineer and circuit designer's bench. They provide DC (direct current) voltage to a device under test such as a circuit board or other product being validated. The equipment is typically set up on the engineer's work area or bench. A variety of types are available all with different features and functions to suit design and debug applications.

Keywords: workbench power supply, rectifier, buck converter, regulator, fritzing

INTRODUCTION

In the new era of technology, the essential of parallel learning is more important to technical based students. This means they must learn the theoretical part and observe the functional device to get better understanding in producing engineering parameters such as voltage and current. The value of voltage and current can be measured by using a multimeter and being compared with the sources of the supply. The power supply is the main unit to produce constant or reliable direct current (DC) component for any load. However, the power supply has the stability issue in maintaining the DC component. The application of rectifier and regulator only makes the power supply producing pulsating DC. Thus, the project has the capacity in designing and fabricating the unit of workbench power supply that is used to provide power to the electrical load. The power supply is an important device for different engineering-related fields and appliances. Everything that provides electrical power to a circuit, the device can be termed as a power supply as it is supplying some power to the circuit. In engineering, power supplies are used for providing the power to different electrical loads in different conditions. There are 3 common types of power supplies which are: linearly regulated power supplies, unregulated power supplies, and switching power supplies. Another type of power supply is also introduced which is a ripple regulated power supply. The different types of power supplies are used to provide power to different circuits and different appliances. Different power supplies come in with both input sources such as AC power supplies and DC power supplies. The voltage supplied by the power supply can be varied with the help of knobs present on the power supplies. The type of input can be also selected with the help of the switch or the button. A typical power supply comprises of components like a transformer, rectifier diodes, filters, and different voltage regulator diodes or voltage regulator ICs.

LITERATURE REVIEW

There are two most familiar DC power supplies are used which are linear power supply and switching power supply. Both the DC power supplies have their own differences based on the characteristics. For linear power supply,

it has the preceding discussion points out two major shortcomings of a linear power supply. It requires a low-frequency (60Hz) transformer. That means the size and weight of the transformer are larger than high frequency transformer. Besides that, the transistors in linear DC power supply operate in active region, incurring a significant amount of power loss. It affected the overall efficiency of linear power supply usually in a range of 30-60% [1].

There is different with the switching power supply. In this type of DC power supply, the switching elements such as power transistors or MOSFETs operate as a switch: either completely off or completely on. By avoiding the operation in active region, power loss of the system is able to reduce. As a result, its efficiency between 0-90% ranges. Since a high-frequency isolation transformer is used, the size and weight of switching power supplies can be significantly reduced [2].

A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a rectifier with a 3-wire input from a transformer with a center-tapped secondary winding.

AC/DC power converters are extensively used in various applications like power supplies, dc motor drives, front-end converters in adjustable-speed ac drives, High Voltage Direct Current (HVDC) transmission, Switch-Mode Power Supply (SMPS), utility interface with non-conventional energy sources, in process technology like welding, power supplies for telecommunications systems, aerospace, military environment and so on [1]. Traditionally, AC-DC power conversion has been dominated by diode or phase-controlled rectifiers which act as non-linear loads on the power systems and draw input currents which are rich in harmonics and have poor supply power factor, thus creating the power quality problem for the power distribution network and for other electrical systems in the vicinity of rectifier.

PROBLEM STATEMENT

There are several problems which may occur with the incoming power supply to a site. These problems cause voltage and current instability which can have a significant impact on equipment operation and power usage.

Voltage stability refers to the ability of a power system to maintain steady voltage levels after a disturbance. The main forms of voltage instability can be categorized as sustained under or overvoltage, transient events and waveform distortion.

Undervoltage describes a sag in voltage for a short period or a sustained reduction in the system voltage level for a period of time (sometimes described as a brownout). Common causes of undervoltage conditions include the start-up of large loads or other long-term system faults.

A transient is a sharp change in voltage or current away from normal operating levels for a short period of time (usually no more than 1ms in duration). It normally occurs due to an event which causes a change in the circuit conditions, internally or externally to the circuit. As a result, an oscillating (both positive and negative change) or 'spike' (high positive change) of voltage occurs, which can be transmitted throughout the system.

Waveform distortion involves the changing of the fundamental supply AC waveform due to influences such as harmonics, DC offset and noise.

SIGNIFICANCE OF RESEARCH

The design of the workbench power supply is intended to produce an approximately 5volts with limiting current values. The simulation of the project helped in the design process, to ensure that the workbench power supply can contribute to the teaching procedure for engineering students. Moreover, the working prototype can show the correct procedure in operating the power supply.

RESEARCH METHODOLOGY

Figure 1 shows a block diagram of the power supply components that used in the project. In line with the design process, it took proteus to run its simulation.

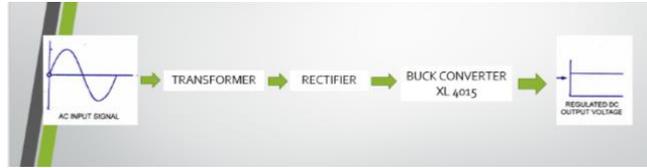


Figure 1: Basic block diagram

The wiring diagram, shown in Figure 2, is to test if the workbench power supply with current limiting get the signal from the AC source or not and also to test the function of the XL4015 (buck converter). The function of XL4015, is to give the output on the display and output to the prob. This XL4015 gets the input from rectifier that convert AC-DC source from transformer is 0-36V and max current of 5A and also controlled with on and off switch.

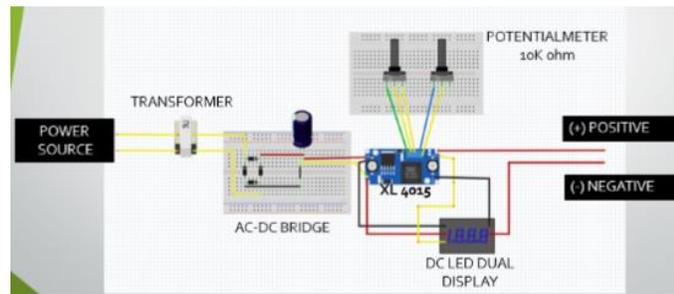


Figure 2: Design of power supply with fritzing

The simulation design shown in Figure 3. It was simulated by using proteus to measure the value of voltage stability and current limiting. The measured values are indicated in the voltmeter.

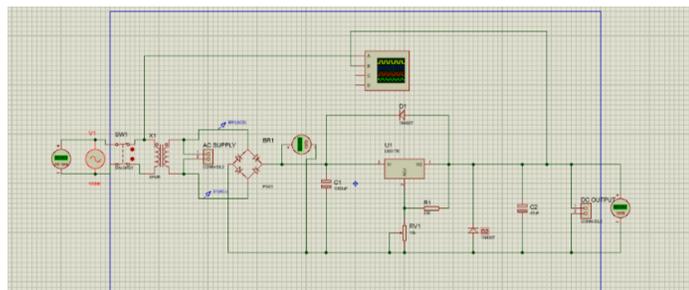


Figure 3: Circuit diagram in Proteus

Figure 4 shows the assembled workbench power supply that is ready to be used observed its function.



Figure 4: The workbench power supply prototype

RESULTS AND DISCUSSION

The results shown in Table 1 and Table 2 indicates the values of voltage measured as compared to the experimental. Both readings are made to do comparison elements and showed the accuracy between the readings. As the values of voltage increased, the multimeter also showed the almost accurate value as observed at the workbench power supply. As the percentage is high, it is said having stability and accuracy.

Table 1: Voltage measurements

No.	PRODUCT DISPLAY (VOLTAGE)	MULTIMETER DISPLAY (VOLTAGE)	ACCURACY (PERCENTAGE %)
1.	0V	0V	NONE
2.	5V	4.95V	99%
3.	10V	9.78V	97.8%
4.	15V	14.97V	99.8%
5.	20V	20V	100%
6.	25V	24.88V	99.92%
7.	30V	29.90V	99.66%
8.	36V	35.7V	99.1%

Figure 5 illustrated the testing results for both product display and by multimeter measurement.

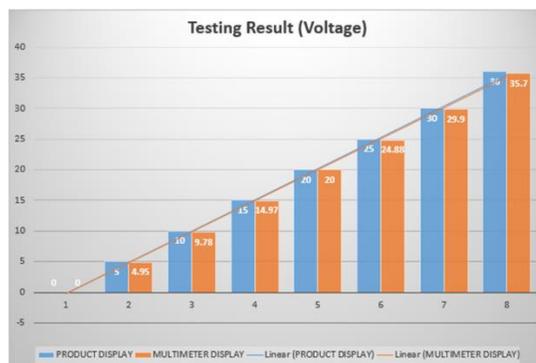


Figure 5: Plotted readings of the workbench power supply

Table 2: Current measurements

NO.	LOAD (LED)	PRODUCT DISPLAY (CURRENT)	MEASUREMENT DISPLAY (AMMETER)	ACCURACY (PERCENTAGE)
1.	LED	25mA	24 mA	96 %
2.	LED	30mA	28 mA	93 %
3.	LED	1A	0.98 A	98 %
4.	LED	3A	2.93 A	97.67 %
5.	LED	5A	5 A	100 %

*make a short circuit and add the led light

As observation towards the result, the rectifier circuit are function for converting the AC-DC that had supply from transformer. Then, a XL4015 (buck converter) function for DC-DC power converter which steps down voltage while stepping up current from transformer to its output (load). After that, the output voltage quite in lack by few percentage cause of the buck converter that has been apply to control the output from the transformer. Lastly, after including the buck converter, the system has increasing the value of current by 1.1% from the input of the buck converter to the load.

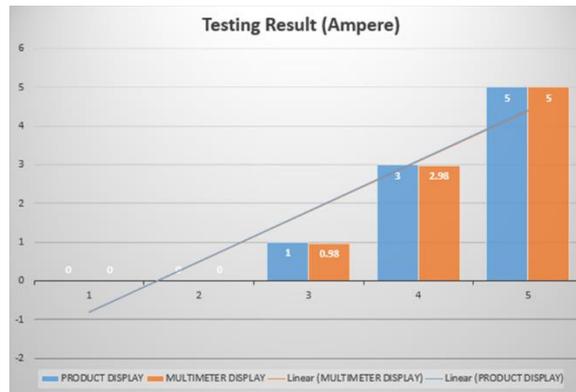


Figure 6: Plotted readings of the workbench power supply

CONCLUSION AND RECOMMENDATION

Due to the needs of laboratory equipment for learning tools with small ratings values of voltage and current has been developed. The project has successfully completed as the unit of workbench bench power supply that can provide the value of voltage and limited range of current. It has the voltage stability, meaning that the valid for a limited range of current.

Besides, the specification of the designed power supply has been fabricated. The output measurements showed that the developed power supply was effective, and the measured values gave minima variation from the nominal designed values. The developed system is cost effective, robust and very useful for learning tools and laboratory experimental purposes.

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