



Sudan University of Science & Technology

College of Engineering

Biomedical Engineering Department



Research Submitted for Fulfillment of Bachelor Degree in Biomedical
Engineering

Power supply stabilization for medical instrumentation

Presented by:

- Alaa Almahdi Mohamed
- Hanan Buraie Abdalrahman
- Nahla Hassan Suliman

Supervised by:

- **Dr. Mohamed Yagoub Esmail**

August 2014

ABSTRACT

Due to the importance of giving a stable voltage to all electrical devices, especially medical devices and to prevent sided effects voltage fluctuation, voltage stabilizers is essentially be used to give a stable output voltage for the medical devices which guarantee protection of the devices against electric burns for internal components, this will result to obtain better working performance in healthcare environment.

The stabilizer proposed was designed and tested using dimmer circuits and microcontroller to maintain constant output voltage.

المستخلص

نظرا لأهمية إمداد الأجهزة الكهربائيه بفولتيه مستقره أو ثابتة خاصة الأجهزة الطبيه, وذلك لحمايتها من تأثير تذبذب الكهرباء؛ كان لابد من إستخدام منظمات الجهد لتعطي فولتيه مستقره للأجهزة الطبيه, وذلك لضمان حماية الجهاز من تلف المكونات الداخليه, مما يؤدي إلى أداء أفضل في مجال الرعاية الصحية.

تم تصميم واختبار منظم الجهد باستخدام (dimmer circuits and microcontroller) لاعطاء فولتية خرج ثابتة.

List of Abbreviations:

AC	Alternating Current.
DC	Direct Current.
IC	Integrated Circuit.
LCD	Liquid Crystal Display.
RAM	Random Access Memory.
EEPROM	Electrically Erasable Programmable Read Only Memory.
TRIAC	Triode for Alternating Current.
DIAC	Diode for Alternating Current.
AVR	Automatic Voltage Regulator.
CVT	Constant Voltage Transformer.
SCR	Silicon Controlled Rectifier.
THD	Total Harmonic Distortion.

Electrical units table:

Parameter	Symbol	Measuring unit
Voltage	Volt	V
Current	Ampere	I
Resistance	Ohm	R or Ω
Capacitance	Farad	C
Power	Watts	W

Table of Contents

Dedication.....	Error! Bookmark not defined.
Acknowledgement	Error! Bookmark not defined.
ABSTRACT.....	2
المستخلص.....	3
List of Abbreviations:.....	4
Electrical units table:.....	5
Table of Contents	6
Table of Figure	8
Chapter one	Error! Bookmark not defined.
General introduction	9
1.1 Introduction:.....	9
1.2 Problem Statement:.....	10
1.3 Objective:	10
1.4 methodology:	11
1.5 Hypothesis:.....	11
1.6 Thesis organization:	11
Chapter two	Error! Bookmark not defined.
Theoretical Foundation.....	Error! Bookmark not defined.
2.1 General definition of Voltage regulator:	Error! Bookmark not defined.
2.2 Type of voltage regulator:.....	Error! Bookmark not defined.
2.2.1 Electromechanical regulators:	Error! Bookmark not defined.
2.2.2 Automatic voltage regulator:.....	Error! Bookmark not defined.
2.2.3 Coil-rotation AC voltage regulator:	Error! Bookmark not defined.
2.2.5 DC voltage stabilizers:	Error! Bookmark not defined.
2.2.7 Combination (hybrid) regulators:	Error! Bookmark not defined.
2.2.8 Zener Diode as Voltage Regulator:	Error! Bookmark not defined.
Chapter three.....	Error! Bookmark not defined.
Methodology and design.....	Error! Bookmark not defined.
3.1 Block diagram:	Error! Bookmark not defined.
3.2 Circuit analysais:	Error! Bookmark not defined.

3.3 Circuit diagram:	Error! Bookmark not defined.
3.4 Circuit component:	Error! Bookmark not defined.
3.4.1 Transformer:	Error! Bookmark not defined.
3.4.2 Bridge:	Error! Bookmark not defined.
3.4.3 Microcontroller "At mega 16":	Error! Bookmark not defined.
3.4.4 LCD:	Error! Bookmark not defined.
3.4.5 ULN2003:	Error! Bookmark not defined.
3.4.5 Relay:	Error! Bookmark not defined.
3.4.6 Triac:	Error! Bookmark not defined.
3.4.8 Diac:	Error! Bookmark not defined.
3.4.9 Dimmer circuit:	Error! Bookmark not defined.
Chapter four	Error! Bookmark not defined.
Result and discussion	Error! Bookmark not defined.
4.1 Result:	Error! Bookmark not defined.
4.1.1 Practical circuit result:	Error! Bookmark not defined.
4.1.2 Simulation result:	Error! Bookmark not defined.
4.2 Circuit Cost:	Error! Bookmark not defined.
4.3 discussion:	Error! Bookmark not defined.
4.3.1 Observation about result:	Error! Bookmark not defined.
4.3.2 Principle of transformer:	Error! Bookmark not defined.
Chapter five	Error! Bookmark not defined.
Conclusion and recommendations	Error! Bookmark not defined.
5.1 Conclusion:	Error! Bookmark not defined.
5.1.1 The advantages of the stabilizer:	Error! Bookmark not defined.
5.1.2 The disadvantages of the stabilizer:	Error! Bookmark not defined.
5.2 Recommendation:	Error! Bookmark not defined.
Reference	
Appendix	

Table of Figure

(Figure 3.1 : block diagram)	Error! Bookmark not defined.
(Figure 3.2 : circuit diagram).....	Error! Bookmark not defined.
(Figure 3.3 : step down transformer)	Error! Bookmark not defined.
(Figure 3.4 : bridge rectifier)	Error! Bookmark not defined.
(Figure 3.5 : microcontroller at mega 16)	Error! Bookmark not defined.
(Figure 3.6 : LCD 16x2)	Error! Bookmark not defined.
(Figure 3.7 : Current Amplifier high voltage high current)	Error! Bookmark not defined.
(Figure 3.8 : triac bt136)	Error! Bookmark not defined.
(Figure 3.9 : diac circuit symbol)	Error! Bookmark not defined.
(Figure 3.10 : phase control of dimmer circuit)	Error! Bookmark not defined.
(Figure 3.11 : dimmer circuit)	Error! Bookmark not defined.
(Figure 4.1 : voltage stabilizer circuit)	Error! Bookmark not defined.
(Figure 4.2 : voltage stabilizer circuit)	Error! Bookmark not defined.
(Figure 4.3 : input voltage=228, output voltage=220).....	Error! Bookmark not defined.
(Figure 4.4 : input voltage=249, output voltage=220).....	Error! Bookmark not defined.
(Figure 4.5 : input voltage=238, output voltage=220).....	Error! Bookmark not defined.
(Figure 4.6 : input voltage=224, output voltage=220).....	Error! Bookmark not defined.
(Figure 4.7 : input voltage=235, output voltage=220).....	Error! Bookmark not defined.
(Figure 4.8 : input voltage=246, output voltage=220).....	Error! Bookmark not defined.

General introduction

1.1 1.1 Introduction:

At any point of time, a power system operating condition should be stable, meeting various operational criteria, and it should also be secure in the event of any credible contingency. Present day power systems are being operated closer to their stability limits due to economic and environmental constraints. Maintaining a stable and secure operation of a power system is therefore a very important and challenging issue. Voltage instability has been given much attention by power system researchers and planners in recent years, and is being regarded as one of the major sources of power system insecurity. Voltage instability phenomena are the ones in which the receiving end voltage decreases well below its normal value and does not come back even after setting restoring mechanisms such as VAR compensators, or continues to oscillate for lack of damping against the disturbances. Voltage collapse is the process by which the voltage falls to a low, unacceptable value as a result of an avalanche of events accompanying voltage instability.

A voltage stabilizer is a device that maintains a relatively constant output voltage even though its input voltage may be highly variable.

Power quality may be defined as the “Degree to which both the utilization and delivery of electric power affects the performance of electrical equipment.” From a customer perspective, a power quality problem is defined as “Any power problem manifested in voltage, current, or frequency deviations that results in power failure or disoperation of customer equipment”.

Some machines such as medical instruments are very sensitive to slightest change in the power supply. It is very important for them to take care of the frequently occurring power quality defects. The five most common Power Quality defects defined are:

- i. Under Voltage: When the operating falls to a low value due to fault voltage.

- ii. Dips or Surges: Fluctuations leading to frequent increase and decrease in the magnitude of the supply.
- iii. Transient: A Spike in the sinusoidal voltage of the supply.
- iv. Harmonics: Voltage or Currents that are some integer multiple of operating specifications which cause distortion.
- v. Burnouts: Period of very low frequency voltage or sometimes even zero leading to reduced power delivery.

This project will be focusing on voltage fluctuation.

1.2 1.2 Problem Statement:

The potential benefit from the use of a medical device ranges from relieving minor irritations to correcting life threatening conditions. If the device design and manufacturing processes are done adequately, there is a high probability that the device will perform as desired at the time it is manufactured. However, there are many factors that can affect how long after manufacturing the device will maintain the ability to fully perform the intended function. One of these factors that cause problems in the device is the fluctuation of electricity.

During the transmission of electricity from the source of generation and until it reach the hospital, there are a lot of factors that lead to undesirable changes, that inevitably affects the efficiency of the medical instrument and that may cause a risk to the patient and/or the working team.

1.3 1.3 Objective:

Design stabilizer to stabilize the input voltage to provide constant output voltage that supply the medical instrument, this helps to maintain stable electricity to the instrument. The main purpose of this device is to protect sensitive loads from fluctuation in the supply side.

1.4 1.4 methodology:

Series of steps were used regularly (proteus 7) to establish design of voltage stabilizer depending on theoretical background and mathematical principle to obtain components values as the following briefly discussion in the next chapters.

1.5 1.5 Hypothesis:

- Electricity fluctuate in a certain range, and must be adjusted to suit the electricity needed by the medical device.
- Adjustment the alternating voltage “AC” in order to reach certain level ”220V ac” this include:
 - In the case of electricity less than 220V AC step it up to reach 220V AC.
 - In the case of electricity more than 220V AC step it down to reach 220V AC.
 - When the input is 220V AC the output voltage remains such as the input.

1.6 1.6 Thesis organization:

This project contain five chapters organized as follows:

- Chapter one (General introduction): Introduction – Problem statement –Objective – Hypothesis – Thesis organization.
- Chapter two (Theoretical foundation): General definition of voltage regulator - Types of voltage regulator.
- Chapter three (Methodology): Circuit design (Block diagram and Circuit diagram) – Circuit analysis – Circuit component.
- Chapter four (Results and Discussion): Results – Circuit cost – Discussion.
- Chapter five (Conclusion and Recommendation): Conclusion – Recommendation – References.