

Design & Development of a Variable Electric Field Generator

By

Muhammad Bilal 01-133142-074

Hamza Zaman 01-133142-045

Muhammad Hassan 01-133142-081

Supervised by

Dr. Syed Asim Ali Shah



2014-2018

A Report is submitted to the Department of Electrical Engineering,
Bahria University, Islamabad.

In partial fulfillment of requirement for the degree of BS(EE) .

Certificate

We accept the work contained in this report as a confirmation to the required standard for the partial fulfillment of the degree of BS(EE).

Head of Department

Supervisor

Internal Examiner

External Examiner

Dedication

We dedicate this dissertation to our lecturers/faculty members who have supported us throughout the process. We are also very thankful to our parents who gave us both the moral and financial support needed to achieve the milestone. We are also forever indebted to sir Majid Shehzad (Late) for being a great spiritual mentor.

Acknowledgements

We are greatly thankful to our supervisor Dr. Syed Asim Ali Shah who has provided us with a very thorough assistance and a constant support throughout the project. We would also like to thank the PHD researchers we are assisting, Mr. Muhammad Umair Alam and Mr. Badr Ali for their guidance.

Abstract

Automation and the minimization of the hardware are the factors that are trending nowadays in order to increase the effectiveness and productivity of the system. Variable electric field has a large amount of applications nowadays. Ion Implementation makes use of the Electric Fields. Electric Fields are also used in Van De Graaff Generator. Food preservation methods also make use of the Electric Fields. Electric Fields are also used to measure cell and tissue properties. Our work presented here is based around the development of a variable electric field generator. This product is central to advanced industrial applications like contactless gripper, ion implantation and silicon chip. We have developed a system that is able to generate, control and monitor variable electric field. The developed system is capable of producing static as well as variable charges and can be implemented in any dynamic environment. The system also monitors and measures the field produced by the developed electric field generator. Initially we developed the mathematical model of our system. Afterwards, our developed model has been executed on simulation tools. After finalization of design parameters, hardware of the system has been developed. The developed hardware has the capability of generating variable Electric Field using solid state tesla coil. Sensor for field measurement has been incorporated by using National Instruments DAQ USB 6001. The same sensor provides feedback to controller which controls, monitors and updates the field according to the user's requirement.

Table of Contents

Chapter # 1 Introduction	10
1.1: Project Background / Overview:.....	111
1.2: Problem Description	Error! Bookmark not defined. 3
1.3: Project Objectives	133
1.4: Project Scope	13
Chapter # 2 Literature Review	15
2.1 Basic Concepts.....	15
2.2 Previously Existing Methods	17
2.3 Review of the research papers	20
Chapter # 3 Requirement Specifications	22
3.1 Existing Systems.....	233
3.2 Proposed System.....	255
Chapter # 4 System Design.....	30
4.1 System Architecture.....	31
4.2 Design Constraints.....	33
4.3 Design Methodology.....	36
4.4 Sensor Calibration.....	36
Chapter # 5 System Implementation	37
5.1 System Architecture.....	38
5.2 Tools and Technology Used	39
5.3 Processing Logic/ Algorithms.....	41
Chapter # 6 System Testing and Evaluation.....	44
Chapter # 7 Conclusion.....	66
References.....	68
Appendices.....	70

Table of Figures

Figure 2.0	Tesla Coil Simulation	16
Figure 2.1	LabVIEW software Simulation	17
Figure 2.2	Van De Graaff generator	19
Figure 3.0	Hardware Flow Diagram	25
Figure 3.1	Software Flow Diagram	26
Figure 3.2	Block Diagram Stepper Motor/PWM	28
Figure 3.3	Front Panel Stepper Motor/PWM	29
Figure 4.0	Complete system flow diagram	31
Figure 4.1	Simple tesla coil implemented on PCB	32
Figure 4.2	Porteous simulation of the modified SSD tesla coil	33
Figure 4.3	A 200 A Hall Effect Sensor Module	34
Figure 5.0	NI DAQ USB 6001	39
Figure 5.1	The designed SSD Tesla Coil	39
Figure 5.2	The ACS 712x30A module acquired	40
Figure 5.3	The logic implementation for the sensor calibration	41
Figure 5.4	The front panel for the sensor calibration in LabVIEW	42
Figure 5.5	The graph obtained during the sensor calibration	43
Figure 6.0	Front Panel LabVIEW	45
Figure 6.1	Desired field Graph for the 1st input	46
Figure 6.2	Feedback Graph generated against the 1st input	47
Figure 6.3	Current graph formed for the 1st input	47
Figure 6.4	Measured Field graph generated for the 1st input	47
Figure 6.5	Desired field graph for the 2nd input	48
Figure 6.6	Feedback Graph generated in response to the 2st input	48
Figure 6.7	Current graph formed for the 2nd input	48
Figure 6.8	Measured Field graph generated for the 2nd input	49
Figure 6.9	Desired field Graph for the 3rd input	49
Figure 6.10	Feedback Graph generated against the 3rd input	50
Figure 6.11	Current graph formed for the 3rd input	50

Figure 6.12	Measured Field graph generated for the 3rd input	50
Figure 6.13	Desired field graph for the 4th input	51
Figure 6.14	Feedback Graph generated in response to the 4th input	51
Figure 6.15	Current graph formed for the 4th input	52
Figure 6.16	Measured Field graph generated for the 4th input	52
Figure 6.17	PWM Command Graph for the 1st input	53
Figure 6.18	A graph of the feedback, current and electric field generated for 1st input	53
Figure 6.19	The current generated at the tesla coil's output for the 1st input	54
Figure 6.20	The measured/output electric field for 1st input	54
Figure 6.21	PWM Command Graph for the 2nd input	55
Figure 6.22	A graph of the feedback, current and electric field generated for 2nd input	55
Figure 6.23	The current generated at the tesla coil's output for the 2nd input	56
Figure 6.24	The measured/output electric field for 2nd input	56
Figure 6.25	PWM Command Graph for the 3rd input	57
Figure 6.26	A graph of the feedback, current and electric field generated for 3rd input	57
Figure 6.27	The current generated at the tesla coil's output for the 3rd input	58
Figure 6.28	The measured/output electric field for 3rd input	58
Figure 6.29	PWM Command Graph for the 4th input	59
Figure 6.30	A graph of the feedback, current and electric field generated for 4th input	59
Figure 6.31	The current generated at the tesla coil's output for the 4th input	60
Figure 6.32	The measured/output electric field for 4th input	60
Figure 6.33	PWM Command Graph for the 5th input	61
Figure 6.34	A graph of the feedback, current and electric field generated for 5th input	61
Figure 6.35	The current generated at the tesla coil's output for the 5th input	62
Figure 6.36	The measured/output electric field for 5th input	62
Figure 6.37	PWM Command Graph for the 6th input	63
Figure 6.38	A graph of the feedback, current and electric field generated for 6th input	63
Figure 6.39	The current generated at the tesla coil's output for the 6th input	64
Figure 6.40	The measured/output electric field for 6th input	64
Figure 6.41	LabVIEW Program's block diagram	65