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**DESIGN AND IMPLEMENTATION
OF OUTPUT CURRENT SOURCE
CIRCUIT FOR NEUROMUSCULAR
FES DEVICE**

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ABSTRACT

Spinal Cord Injury (SCI) causes a great discomfort and misery to human life. Loss of communication between the brain and the muscles is the main reason of such misery and discomfort. Functional electrical stimulator (FES) device is typically used to restore the muscle function by producing stimuli in the form of current through electrodes which are strapped on the patient's skin. The FES device mainly consists of a digital controller, a Digital to Analog Converter (DAC), an interface circuitry and electrodes. The digital controller (Microcontroller/ FPGA) processes the stimulus parameters to generate arbitrary stimulus pulse. The DAC converts the digital output data from the controller into an analogue signal before it is transferred to the interface circuit. Constant Voltage Source (CVS) and Constant Current Source (CCS) are the two main types of interface circuits. However, the CCS is preferred over the CVS due to safety and easy maintenance. For the CCS, an output current source circuit is required to amplify and transfer the generated current from the DAC to the electrodes. In the simulation circuit, the DAC0800 was used while the Digilent PmodR2R DAC was used for hardware measurement. A few types of CCS output source circuits were focused in this project such as Monophasic, Howland current pump and Improved Howland output source. Proteus Design Suite software was used to design and simulate the output source circuits. The, hardware circuitries were developed and connected to an FPGA board for output current generation and measurement purpose. Several output currents were measured across three ranges of resistive output loads (500, 1k and 2k ohm). In the simulation, it was found that lower resistive load produces higher output current. Improved Howland circuit generated output current in the range of 7 – 15mA. Howland charge pump circuit generated output current in the range of 5 -15mA. The monophasic circuit produced output current around 4 – 11mA. In the hardware measurement, the monophasic output current source circuit generated output current in the range of 21 – 26mA while the improved Howland output circuit generated output current around 1mA only. The Howland charge pump circuit was observed and could not produce any output current at all during the hardware measurement. Additionally, the designed CCS circuits were also used to validate the digital controller (FPGA) functionality in generating a few arbitrary stimulation waveforms.

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TABLE OF CONTENTS

	PAGE
AUTHOR'S DECLARATION	i
ABSTRACT	ii
ACKNOWLEDGEMENT	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vi
LIST OF FIGURES	vii
LIST OF APPENDICES	ix
LIST OF SYMBOLS	x
LIST OF ABBREVIATIONS	xi
CHAPTER 1 INTRODUCTION	1
1.1 Research Background	1
1.2 Problem Statement	2
1.3 Project Objectives	3
1.4 Significance of Study	4
1.5 Scope of project	4
1.6 Thesis Outline	4
CHAPTER 2 LITERATURE REVIEW	6
2.1 Spinal Cord Injury (SCI)	6
2.2 Functional Electrical Stimulation (FES)	7
2.3 Human Muscle	8
2.4 Constant Voltage Source	9
2.5 Constant Current Source	10
CHAPTER 3 METHODOLOGY	15
3.1 Overall System Overview of FES	15
3.1.1 DAC Circuitry	16
3.1.2 PmodR2R Schematic	17

3.2	Internal Architecture of Current Source Circuit	19
3.2.1	Monophasic Current Source	19
3.2.2	Howland Charge Pump Current Source	21
3.2.3	Improved Howland Current Source	23
3.3	Design Methodology	24
CHAPTER 4 RESULT AND DISCUSSION		26
4.1	Simulation Result	27
4.1.1	Monophasic Current Source Circuit	27
4.1.2	Howland Charge Pump Circuit	31
4.1.3	Improved Howland Circuit	34
4.1.4	Simulation Result Summary	38
4.2	Hardware Result	39
4.2.1	Hardware Measurement Setup	39
4.2.2	Monophasic Current Source Circuit	41
4.2.3	Improved Howland Circuit	46
4.2.4	Hardware Result Summary	51
CHAPTER 5 CONCLUSION AND FUTURE RECOMMENDATION		52
5.1	Conclusion	52
5.2	Problems Encountered	54
5.3	Future Recommendations	54
REFERENCES		55
APPENDICES		58