# DELTA SIGMA DIGITAL ANALOG CONVERTER CIRCUIT DESIGN FOR NEUROCHEMICAL SENSING

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## ABSTRACT

The aim of this project is to measure dopamine signal current via In Vivo Voltammetry System. Voltammetry is a category of electroanalytical methods used in analytical chemistry. In voltammetry, information about an analyte is obtained by measuring the current as the potential is varied. In Vivo Voltammetry is used to measure dopamine signal current when potential applied to the dopamine while subject still alive. In Vivo Voltammetry system consists of several parts such as Op-Amp, Voltage Frequency Converter, Digital Analog Converter and Potentiostat. Specifically, this project is to design and simulate a Digital Analog Converter (DAC) by implementing Delta Sigma Modulator. Simulations are done in PSpice software. Delta Sigma DAC is chosen to meet the desired voltage output 900 miliVolts (mV) and frequency 4 Hertz (Hz). This type of DAC is different from other common used DAC because it provides high resolution for accuracy implementation. Potentiostat requires voltage supply from a high resolution, accurate and low speed DAC.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Neurochemical monitoring of brain tissue with microdialysis allows continuous analysis of extracellular substances such as glutamate, glycerol, lactate and dopamine over a certain period of time.

Dopamine has many functions in the brain, including important roles in behavior and cognition, motor activity, motivation and reward, sleep, mood, attention, and learning. Dopaminergic neurons of the midbrain are the main source of dopamine in the brain. Dopamine has been shown to be involved in the control of movements, the signaling of error in prediction of reward, motivation, and cognition [7].

The concentration of dopamine (analyte) can be measured using Voltammetry. Voltammetry is a category of electroanalytical methods used in analytical chemistry and various industrial processes. In voltammetry, information about an analyte is obtained by measuring the current as the potential is varied.

The Delta Sigma modulation is a method for encoding high resolution signals into lower resolution signals using pulse-density modulation. This technique has found increasing use in a range of modern electronic components, such as analog-to-digital and digital-to-analog converters, frequency synthesizers, switched-mode power supplies and motor controls. A DAC circuit which implements this technique can relatively easily achieve very high resolutions while using low-cost Complementary Metal Oxide Semiconductor (CMOS) processes [5].

In this project, Delta Sigma modulation is implemented to DAC. As a result, Delta Sigma DAC characteristics suit to project requirement. Its function is to supply voltage to potentiostat. Potentiostat in In Vivo Voltmetry require accurate voltage in low frequency. PSpice simulation is used to verify Delta Sigma DAC characteristics.