Ain Shams University

Faculty of Engineering

SPECIFICATIONS. CHARACTERISTICS AND PERFORMANCE OF INTEGRATED MOS D/A CONVERTERS

By

NAGY HALIEM IBRAHIEM

A Thesis

Submitted in partial fulfillment for the requirements of the degree of M.SC. in Electronic and Computer Engineering

Supervised by

PROF . DR . M . NABIL SALEH

DR . A . ELHENNAWY

CAIRO - 1990

EXAMINERS COMMITTEE

Name, Title & Affiliation — Signature

1- **PROF. DR. A. A. TALKHAN** .....

Cairo University .

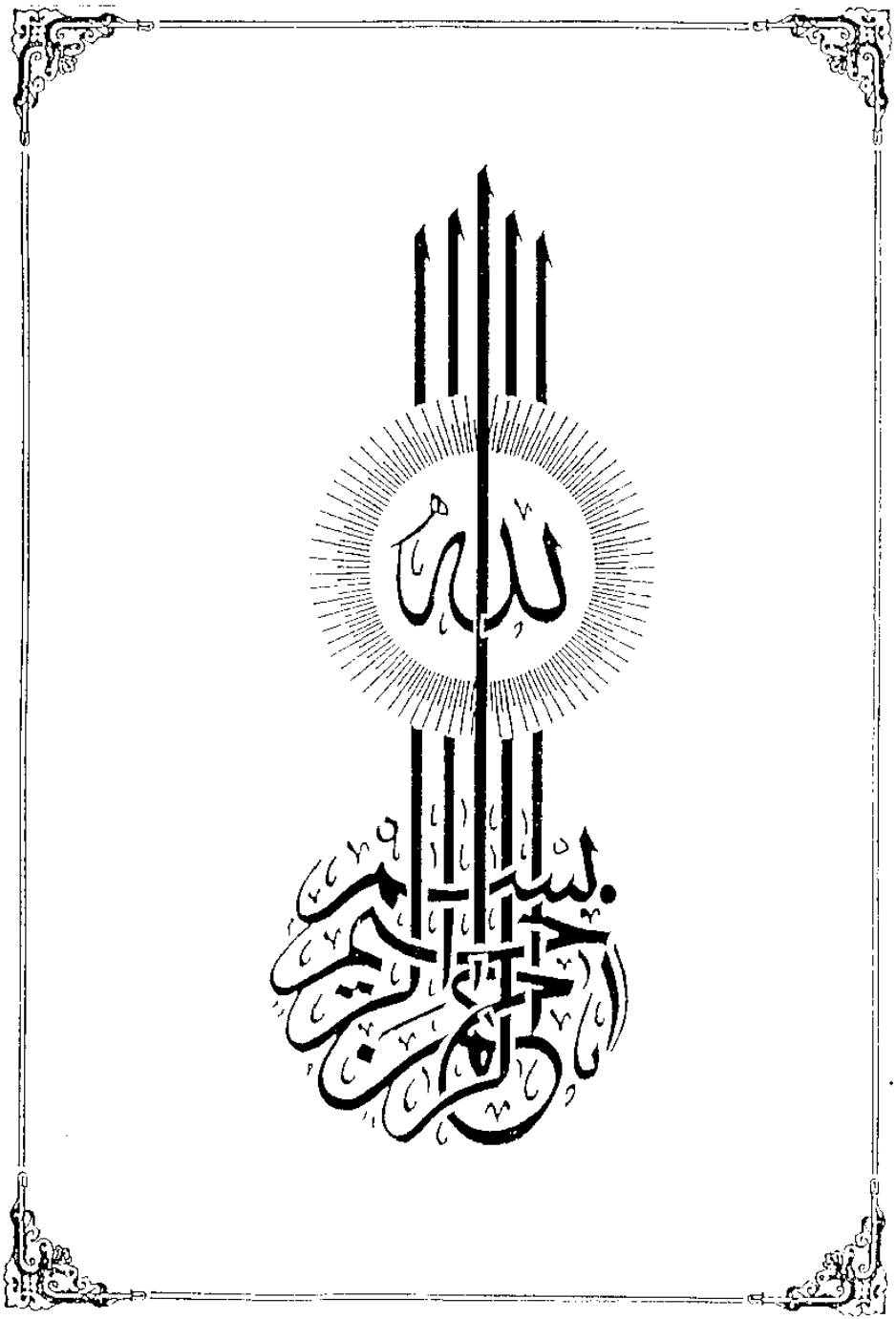
2- **PROF. DR. M. K. EL SAID** .....

Ain Shams University .

3- **PROF. DR. M.N. SALEH** .....

Ain Shams University .

Date / 11 / 1990 .



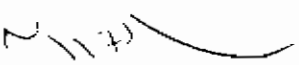
STATEMENT

This dissertation is submitted to Ain Shams University for the degree of M.SC in electronics and computer Engineering.

The work included in this thesis was carried out by the author in the Department of Electronics and Computer Engineering, Ain Shams University, from November 1984 to November 1990 .

No part of this thesis has been submitted for a degree or a qualification at any other university or Institution .

Date : Nov. 1990

Signature : 

Name : Nagy . Haliem . Ibrahiem

TO MY MOTHER ....

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to professor Dr. M. NABIL SALEH for his valuable advice, guidance, continous encouragement, best direction, moral support and critical reading of the manuscript. His general consultation is also appreciated .

The author is also greatly indebted to Dr. A. EL HENNAWY for his significant assistance, valuable suggestions, critical remarks, deep discussion in almost all major and minor topics of this thesis, great help in the analysis of the results and precise reading and corrections of the manuscript . Also deep appreciation to him for his revision of the thesis even when he was abroad and fully busy .

ABSTRACT

The purpose of this thesis is to solve the problems associated with the D/A converters, in other words to improve the characteristics and the specifications of the D/A converters .

In chapter I the thesis presents a survey of the different types of the D/A converters and their operation. In addition to that, it presents the specifications and the sources of errors that may be associated with them, these can be summarized as follows :-

(1) Resolution which is related to the off set voltage of the op-amp and the number of input digits constructing the input digital word .

(2) Accuracy which can be referred to four sources of errors :

a) Gain error which is caused by error in the feed back resistance of the op-amp

b) Offset error which is caused by the offset voltage of [illegible]

c) Reference voltage [illegible]

d) [illegible] error which is caused by the error [illegible] current source resistors and the R[illegible]

the resistances of the switches .

(3) Glitch problem which results due to the inequality of the turn-on and turn-off times of the switches .

(4) Nonlinearity which is caused by the reference voltage variations and the glitches .

(5) Long output settling time which leads to greater error in the high frequencies operation .

(6) Appreciable sensitivity of the converter elements to the ambient temperature .

In chapter II the thesis presents the different compensation techniques which can be used to solve the problems of the converter, also it presents new techniques better than the known techniques to solve these problems :-

(1) Compensation of the offset voltage using the theory of injection of the hot carrier into the floating gate of MOS transistor .

(2) Fine adjustment of the current source resistors using the same above theory .

(3) Stabilization of the reference voltage using simple MOS circuits which stabilize the value of this voltage automatically and quickly against any variations in current drawn or any changes in the used voltage source .

(4) Realization of precise value of the feedback resistance of the op-amp against any changes in the output voltage or any variations in the ambient temperature using hot carrier phenomenon.

(5) Solving the glitch problem using a new MOS circuit which speeds up the turn-on and turn-off times of the switches .

Also in this chapter the thesis presents modeling for each of these techniques and also it discusses the compatibility of these techniques with the integrated circuits technology used in VLSI circuits which is used in the new D/A converters.

In chapter III the thesis presents the simulation results, finally it discusses the results of this study and the simulations results which show the capability of each technique to improve the performance and characteristics of the converter especially when we scale down the converter geometry, this shows that the D/A converter is compatible with the new VLSI MOS technology .

In chapter IV we presented our conclusions and showed thepoints that can be taken into considerationin future researsh.

CONTENTS

CHAPTER II

DESIGN AND SIMULATION OF A DEFECT-FREE MOSFET INTEGRATED D/A CONVERTER

CHAPTER III

SIMULATED RESULTS AND DESIGN PARAMETERS

CHAPTER IV

INTRODUCTION

INTRODUCTION

The aim of this thesis is to introduce a MOS integrated D/A converter of high resolution, accurate, monotonic, speedly operating and glitches free.

D/A converters have many applications which require the above mentioned requirements for best performance. D/A converters are used in control, communications and instruments field. Here we consider few important applications like linear waveform generator, ramp generator, triangular waveform generator, frequency drift measurement, digitally controlled power supply, multiplying D/A converter, Inverse scale factors, digital peak follower, precision analog delay line, digitally controlled variable gain amplifier and digitally controlled adaptive compensating network .

In this thesis we presented in chapter I , the different types of the D/A converters and thier specifications .

In chapter II we presented the already known and used techniques used to improve the specifications and characteristics of the D/A converter, then we presented novel techniques using MOS transistor , these techniques enable to improve specifications and characteristics of the D/A