Ain Shams University

Faculty of Engineering

A NEW INETGRATED VERY SENSITIVE MAGNETODETECTOR

By

MOHAMMED M. Ahmed EL-HADY ATYA

A THESIS

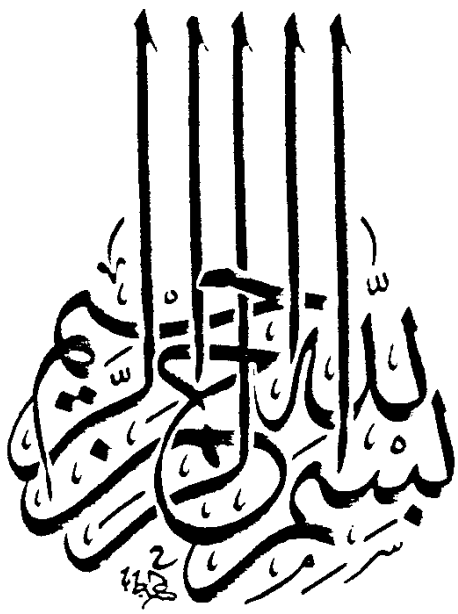
Submitted in partial Fulfillment For The Requirements of The Degree of M.Sc. in Electronics and Computer Engineering

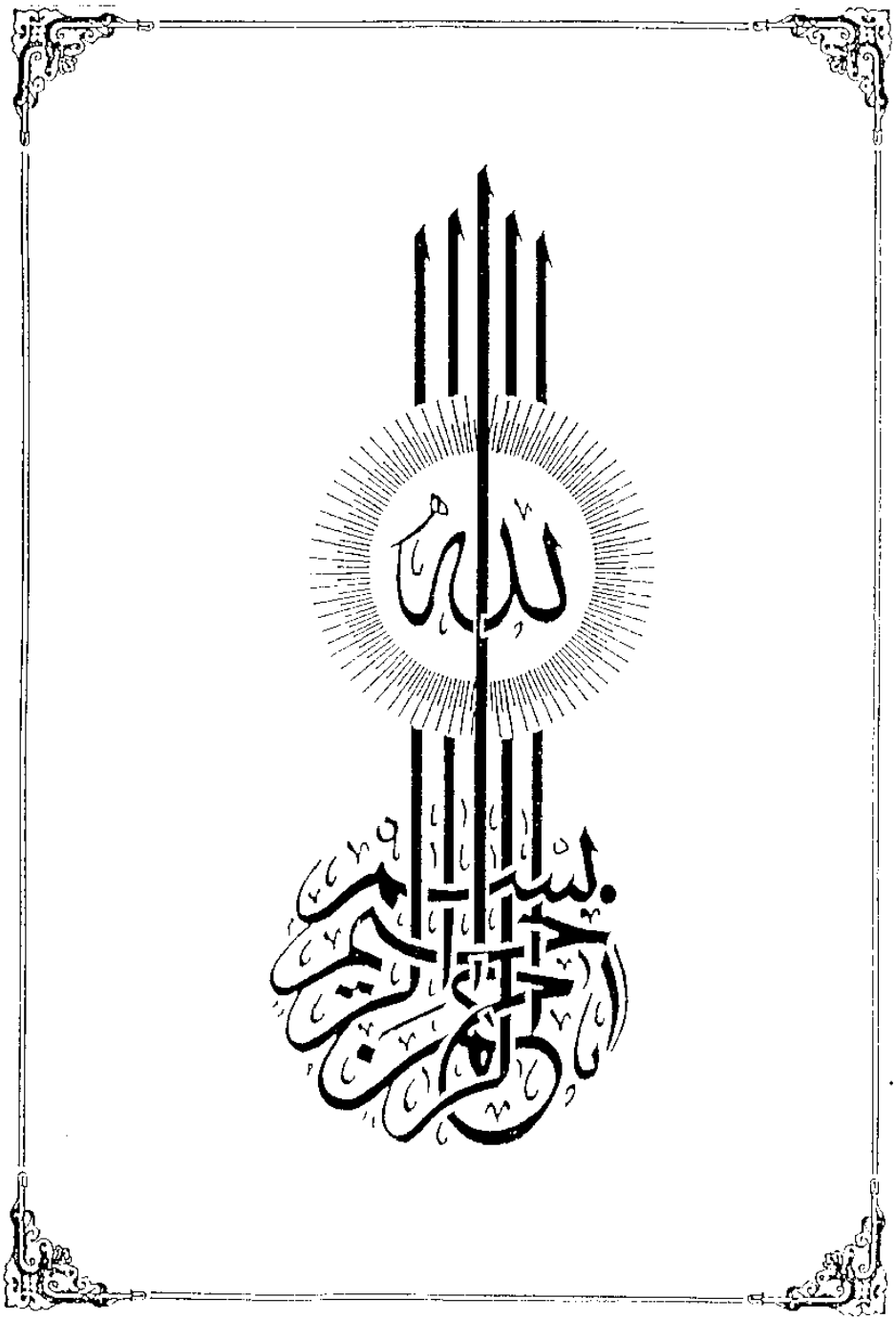
Supervised by

Prof. Dr. M. Nabil Saleh

Dr. A.E. El-Hennawy

Cairo-1988





Examiners Committee

Name, Title & Affiliation	Signature
1. **Prof. Dr. A. A. Talkhan** Cairo University	.....
2. **Prof. Dr. A. Kh. Abo-El Seuod** Alex. University	.....
3. **Prof. Dr. M. N. Saleh** Ain Shams University	.....

Date: / /1988

STATMENT

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 auther in the department of Electronics and Computer, Ain Shams University, from October 1984 to October 1988.

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

Date : Oct. 1988

Signature : M.EL HADY

Name : Mohammed M. El-Hady

To My Father and Mother,

To My Wife,

To My Kids;

Sameh, Amro and

Marwa.

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 auther 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.

It is to my pleasure to present gratifull thanks to **professor Dr. ABD EL-MONEEM BELAL,** the director of the National Telecommunication Center, for the facilities and materials allowed by the NTC laboratories which supported our experimental work of this thesis.

ABSTRACT

This work introduces two orginal entirely-integrated CMOS magnetodetectors which are based on carrier heating phenomena associated with the short channel MOSFET devices. The first is based on hot carrier injection from the MOSFET channel into a splitted U-shaped floating gate. The other is based on hot carrier injection into the substrate and the collection of these carriers by two seperate Hall drains. The general approaches to the proposed magnetodetectors are related to the resultant magnetic lorentz force (Hall effect, magnetoresistance effect, carrier deflection). This magnetic lorentz force is produced by the applied magnetic field to be measured. Theory, design considerations, modeling, simulation and experimental results have been inculded. A new and very precise technique employs a MOS transistor which is forced to operate in its weak inversion region of operation. In this case the channel current varies exponentially with the gate to source voltage and the power consumption is very low. These proposed magnetodetectors are characterized by the following features:

a) Very high sensitivity (40 times greater than that which have been already proposed in Literatures).

b) Very wide dynamic range of measurement (10^{-9} to 10^{-3} T).

c) A single 5v power supply is needed.

e) Compatible with recent IC secalling-down trends.

f) Automatic scale changing can be provided.

g) Controlable detector sensitivity.

These mangetodetectors are very needed for the following applications :

a) Determination and acquisition of the recombination parameters related to the volume or the surface of polcrystalline silicon.

b) Prediction of anisotropy in thin films.

c) Ocean and air navigation.

d) Detection of radiation leakage and

e) Realization of multilevel digital circuits.

A new circuit configuration for a frequency comparator FC, to be used for detecting the polarity of the applied magnetic field, is also introduced. This frequency comparator is characterized by the following advantages :

a) Integrated in MOSFET technology on a single chip.

b) Compatible with VLSI implementation.

c) Very good linearity.

d) Very wide dynamic range of operation.

Theory, principle of operation, modeling, simulation and experimental results related to the proposed frequency comparator are also involved.

Our simulation and experimental results show that the sensitivity and the dynamic range of measurement of the proposed magntetodetectors are dependent on device geometry, biasing conditions, doping profile and surface doping level.

ABBERVIATIONS:

BFC	Magnetic-to-frequency convertor.
CFC	Low-Level current-to-frequency convertor.
CG	Control gate of MOSFET device.
CMD	Classical magnetiodiode.
CMOS	Complementary MOS.
CVD	Chemical vapor deposition.
DAMS	Differential amplification magnetic sensor.
DDM	Dual drain magnetodetector.
ESFI	Epitaxial Silicon Films on Insulator.
FC	Frequency comparator.
F	The magnetodetector output frequancy.
F_1	The output frequancy of CFC_1.
F_2	The output frequancy of CFC_2.
FG	Floating gate of MOSFET device.
HCG	Hot-carrier gate-current based magnetodetector.
MHCG	Modified version of HCG magnetodetector.
MOS	Metal-oxide-semiconductor.
R(F)	The frequency controlled resistor.
SOS	Silicon on saphire.
UJT	Unijunction transistor.
VCC	Voltage-to-current converter.
VLSI	Very large scale integeration.

CONTENTS

F

G