Ain Shams University

Faculty Of Engineering

Analysis And Design Of Wideband Modulator For Spread Spectrum Systems

BY

NOHA KHAIRY SAKR

THESIS SUBMITTED TO THE

ELECTRONICS AND COMPUTER ENGINEERING DEPARTMENT

FOR THE DEGREE OF

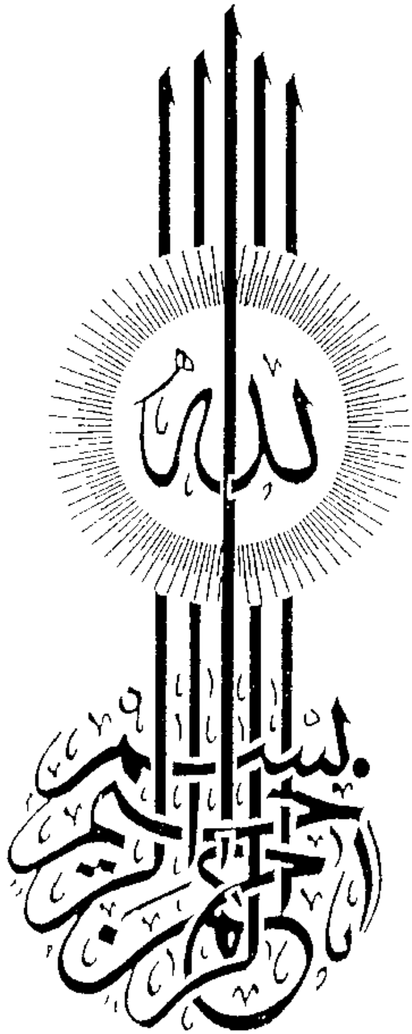
M. Sc.

SUPERVISED BY:

PROF. DR. SAFWAT MAHROUS

MAJ. GEN. DR. IBRAHIM SALEM

DR. HADIA EL HENNAWY.


بسم الله الرحمن الرحيم

Acknowledgement

I would like to express my gratitude to Prof. Dr. Safwat Mahrous, Ain Shams University, for his supervision, guidance and comments throughout the research.

Iam also very grateful to Maj. Gen. Dr. Ibrahim Salem, Military Technical College, for accepting the supervision of my thesis and for his support.

Sincere thanks to Dr. Salwa El Ramly, Ain Shams University , for suggesting the research point and for lecturing some of the pre-required courses.

My deep gratitude to Dr. Hadia El Hennawy, Ain Shams University for her wise planning, patient guidance and endless encouragement.

Abstract

The aim of this thesis is to study the design procedures of a broadband quadriphase shift keying (QPSK) digital modulator, using finline techniques so as to be applied in spread spectrum systems. Two biphase shift keying modulators, one π and the other $\pi/2$ are connected in cascade to achieve the required modulation. The obtained modulator has a bandwidth of about 0.5GHz centered at 10GHz with phase deviation less than $\pm 7^{\circ}$ and a reflection loss variation not more than 0.8db.

The thesis discusses the different spread spectrum modulating techniques, their advantages and disadvantages. A survey is also given about the two main classes of high speed codes used in spread spectrum systems. This survey studies the properties and capabilities of these codes as well as the coders/decoders used for their generation/regeneration. An introduction is then presented to the design of broadband QPSK reflection type modulators used in spread spectrum systems. A modulator is realized with circulators, switching PIN diodes and impedance

matching networks having filter structures. Finally,the practical realization of the QPSK modulator using finline techniques is given. The measurements and results of the modulator circuit using a network analyzer are obtained. It is noticed from the design performance that it agrees quite well with the obtained measured results.

Contents

Abbreviations

SSS	=	spread spectrum systems
PSK	=	phase shift keying
BPSK	=	biphase shift keying
QPSK	=	quadriphase shift keying
VCO	=	voltage controlled oscillator
PN	=	pseudo noise
DS	=	direct sequence
FH	=	frequency hopping
TH	=	time hopping
DDL	=	dispersive delay line

List of Symbols

C	=	channel capacity in bits / sec.
W	=	bandwidth in hertz
f	=	frequency in hertz
S	=	Signal power
N	=	noise power
$P_{BPSK}(f)$	=	power spectral density of bi-PSK
$P_{QPSK}(f)$	=	power spectral density of quadri-PSK
No	=	noise power spectral density
E_b	=	energy / bit
T_b	=	bit duration
Ts	=	symbol duration
Mj	=	jamming margin
Gp	=	process gain
L	=	system implementation losses
D	=	compression ratio
Δf	=	frequency sweep
$\Delta \tau$	=	time increment
R	=	information rate
m(t)	=	modulated signal
I(t)	=	in phase data stream
Q(t)	=	quadrature phase data stream
$\bar{I}$	=	indentity matrix

$\bar{G}$ = generator matrix

$\bar{H}$ = parity check matrix

$\bar{S}$ = syndrome matrix

M = maximum length sequence

d_m = minimum hamming distance

e = number of correctable errors / codeword

E = error sequence

Pe = bit error probability

P_E = symbol error probability

P[e/m(t)] = probability of error assuming m(t) is transmitted

Ls = total series inductance

Cp = stray capacitance

C_f = fringing capacitance

C_j = charge storage capacitance

C_d = diffusion capacitance

Ci = capacitance of the i - layer

Ri = resistance of the i - layer

Rs = total series resistance

Rj = depletion layer resistance

Zi = switchable impedance element

Zm = matching characteristic impedance

Γ = reflection coefficient

L_A = maximum db attenuation

L_m = minimum db attenuation

L_T = db attenuation tolerance

L_R = Tchebyscheff pass band ripple

δ = load decrement

R_A = tuned load resistance

G_A = tuned load conductance

θ = phase angle

B_b = series admittance of a π network

B_c = shunt admittance of a π network

R_f = diode forward resistance

R_r = diode reverse resistance

d_b = notch length

s = notch slot width

Y_{oc} = open circuit admittance

Y_{sc} = short circuit admittance

Introduction

Spread Spectrum communication systems adopting digital methods to transmit information are rapidly progressing in the technical community. In spread spectrum systems the transmitted bandwidth is enlarged to give enhanced detection, interference rejection, ranging requirements and/or message security in various digital communication, navigation, military and test systems.

Chapter 1 covers the different spread spectrum techniques, their advantages and disadvantages. This chapter also classifies spread spectrum techniques according to their four different modulation formats. The most commonly used spread spectrum technique is the direct sequence method associating message security codes. In a direct sequence - spread spectrum system, a carrier in the microwave region is modulated by a digital code sequence. The incoming information signal, which is digitized if it is not in a digital format, is added to a higher speed code sequence. The high speed code sequence dominate the modulating function and hence determines the RF signal bandwidth. The