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Analysis And Design Of Wideband
Modulator For Spread Spectrum Systems

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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 biphasic 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.

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Abbreviations

SSS	= spread spectrum systems
PSK	= phase shift keying
BPSK	= biphas 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
$P_{\text{BPSK}}(f)$	= power spectral density of bi-PSK
$P_{\text{QPSK}}(f)$	= power spectral density of quadri-PSK
N_0	= noise power spectral density
E_b	= energy / bit
T_b	= bit duration
T_s	= symbol duration
M_j	= jamming margin
G_p	= 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
$\bar{I}$	= identity 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
P_e	= bit error probability
P_E	= symbol error probability
$P[e/m(t)]$	= probability of error assuming $m(t)$ is transmitted
L_s	= total series inductance
C_p	= stray capacitance
C_f	= fringing capacitance
C_j	= charge storage capacitance
C_d	= diffusion capacitance
C_i	= capacitance of the i - layer
R_i	= resistance of the i - layer
R_s	= total series resistance
R_j	= depletion layer resistance
Z_i	= switchable impedance element
Z_m	= 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 dominates the modulating function and hence determines the RF signal bandwidth. The