THE SYNTHESIS AND APPLICATION OF POLYPHASE FILTERS WITH SEQUENCE ASYMMETRIC PROPERTIES

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ABSTRACT

The structure, design, properties and application of a new class of polyphase networks are considered. The networks have the special property of being able to discriminate between different types of polyphase input signal. This property can be used to advantage for phase splitting and combining and for single sideband modulation where it can offer considerable improvements with respect to component sensitivity over known equivalent phase splitting networks.

Two broad classes of such filters are studied. The first class, lossless filters, requires constant reactance elements which can be realised using gyrators or complex impedance transformers. The design and practical problems of a complete filter are discussed. The second class, lossy filters, can be constructed using resistors and capacitors only. Such networks are particularly suitable for single sideband modulation and their performance compared with equivalent quadrature modulation designs using phase splitting networks is examined.

Most sequence asymmetric polyphase filters can be designed using a complex single phase equivalent filter. Design methods developed for this purpose include frequency transformation image synthesis and transformation, insertion loss synthesis of equiripple passband arbitary stopband and also elliptic function synthesis which is important for passive R-C types of filter.

Applications discussed include N-path filtering, single sideband modulation and demodulation, polyphase oscillators and complex digital filters.

CONTENTS

GLOSSARY OF PRINCIPAL SYMBOLS AND ABBREVIATIONS

a'_r	a signal vector
a_r	a symmetrical component
a_p	passband ripple
a_s	stopband minimum attenuation
C	capacitance
dB	decibels
f	frequency
g_m	mutual conductance Amps/Volt
G_o	image loss = $A_o + jB_o$
h	$-\frac{1}{2} = j\frac{\sqrt{3}}{2}$
h_{11}	hybrid parameter
H(p)	filter transfer function
I_c	Collector current
j	$\sqrt{-1}$
K	complete elliptic integral of the first kind
L	inductance
N	number of phases or paths
p	complex frequency = $\sigma + j\omega$
q	root of lattice arm impedance ratio
q	elliptic nome
R	resistance
r(t), q(t)	modulating functions (of time)
R_L, Q_K	Fourier coefficients
sn(u,k) ns(u,k) sc(u,k) cn(u,k) dn(u,k)	Doubly periodic Jacobian Elliptic Functions.
t	time

$V(t)$	voltage as a function of time
$V(p)$	voltage as a function of frequency
w) ω) Ω)	angular frequency radians/sec.
ω_p	pole frequency
ω_s	stopband edge frequency
ω_∞	frequency of infinite attenuation
X	reactance
Y	admittance;
Z	transformed frequency domain
Z	impedance
Z_D	driving point impedance
λ	transformed frequency scale
θ) ϕ)	phase angle

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