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PERFORMANCE ANALYSIS OF PARTIALLY COHERENT BPSK IN THE PRESENCE OF ISI

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ABSTRACT

In this paper, we analyze the performance of coherent BPSK systems in the presence of ISI and carrier phase error. We consider diversity system with L-branch signals that being detected using postdetection equal-gain combining (EGC) receiver. The diversity branches are assumed to experience slow, flat, and uncorrelated fades. Two performance criteria are considered: the average bit-error probability (BEP) and the signal-to-noise ratio (SNR) gain penalty due to the sampling time jitter. The analytical results are presented along with results obtained by using quasi-analytical simulation technique.

Index Terms— ISI, partially coherent, wireless communications, diversity, fading

1. INTRODUCTION

Intersymbol interference (ISI) is a signal-dependent form of interference that arises when digital data transmitted over a band-limited channel. The receiver must recover symbol timing perfectly, and jitters in the receiver sampling instants may result in ISI whether the transmitted signals are distorted or not. On the other hand, for efficient coherent transmission over wireless links, reliable channel phase estimation is critical. However, due to the time-variant characteristic of wireless channel, neither the symbol timing nor the carrier phase can be derived perfectly which results in degradation in the system performance. Since the exact evaluation of the performance and the resulting degradation is formidable task, we present a unified methodology to analyze the performance of coherent BPSK systems in the presence of ISI and carrier phase error (partially coherent detection).

A considerable amount of work has been done to evaluate the performance of digital communication systems corrupted by ISI. The effect of cochannel interference (CCI) and ISI on the error rate performance of BPSK in single channel Rayleigh fading and Nakagami-m fading are investigated in [1] and [2], respectively. Abu-Dayya and Beaulieu [3] analyzed the BEP performance of coherent BPSK for dual-branch EGC under Nakagami-m fading in the presence of CCI and ISI. All the previous works assumed perfect carrier phase recovery. In a recent paper [4], we studied the error rate performance of partially coherent PSK systems in fading environment with EGC. But, in this study, perfect symbol synchronization is assumed so that the effect of ISI was not taken into account. To our knowledge, the effect of ISI on the performance of partially coherent BPSK faded signals has not been investigated so far in the literature.

2. SYSTEM AND CHANNEL MODELS

In our study, we assume a total number of L independently fading branches are available and being combined using EGC technique. The received complex baseband signal on the lth branch can be written as

$$r_l(t) = g_l s(t) + n_l(t), \quad l = 1, 2, \cdots, L \tag{1}$$

where $g_l = \alpha_l e^{j\phi_l}$ is the channel flat fading gain in where ϕ_l is the carrier phase and α_l is the fading envelope. Depending on the nature of the propagation medium, the Rician and Nakagami fading models are typically used to represent α_l. In (1), the complex Gaussian processes $n_l(t)$ are independent and identically distributed (i.i.d.) with zero means. In real case, the transmitted complex baseband signal $s(t)$ can be written as

$$s(t) = \sqrt{2P_b} \sum_{k=-\infty}^{\infty} b_k h_T(t - kT) \tag{2}$$

where P_b is the bit average power and b_k is the binary uncorrelated information bit in the kth signaling interval. In BPSK modulation, b_k takes one of the values {-1,+1} with equal probabilities. The pulse $h_T(t)$ is the impulse response of the transmitter filter and T is the bit interval. During the analysis, the transmitter filter is assumed to have a square root raised-cosine frequency response with a rolloff factor β ($0 \leq \beta \leq 1$).
Assuming partially coherent detection and that the matched filter outputs are sampled at times $t_k = t_0 + kT$ (t_0 is the sampling time jitter and k taking on integer values), the combiner decision statistic for the kth signaling interval

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