IEEE 802.11

WIRELESS ACCESS METHODS AND PHYSICAL LAYER SPECIFICATIONS

Title: **Modulation Specifications for 2Mb/s DS-SS System**

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Abstract

For the adopted DQPSK/OQPSK standard of the IEEE802.11 Direct Sequence Spread Spectrum (DS-SS) system, specifications of the differential encoding, chip staggering (0.5Tc) and modulation technique are highlighted. Interoperable DQPSK and OQPSK as well as a fully compatible nonlinearly amplified FQPSK (a subclass of OQPSK) are also included. In reference [30], a nonlinearly amplified DBPSK method, which is compatible with the 1Mb/s DS-SS conventional DBPSK is described. This contribution for the proposed standard as well as the chip staggering idea has been developed based on inputs of the   organizations including Telxon and UC Davis (USA), Lannair (Israel), Telesystems (Canada), NCR/ATT (Netherland/USA), and NTT (Japan).

I.   Introduction

During the IEEE802.11 1993 meeting in November, the DS-SS committee approved with a large majority the adoption of DBPSK for 1Mb/s and DQPSK/OQPSK for 2Mb/s.

We present this document with the hope that its content will become part of the final DS-SS standard. As an illustration, we present the configurations and the spectral performances of OQPSK DS-SS system with 100 mw nonlinear power amplifier (NLA) and FQPSK [1,2,3,4] DS-SS system with 1 watt NLA.

II.   DQPSK, OQPSK and the Compatible FQPSK DS-SS System

The modulation block diagram of the DQPSK interoperable OQPSK and the fully compatible FQPSK DS-SS system with 2Mb/s rate is shown in Fig.1. In the modulator, the input I, Q binary data sequences are encoded by the conventional differential encoder. Based on the UC Davis investigation, we agree with NCR/AT 1 (Netherland/USA) and Telxon (USA) [27,28] that the same differential encoding strategy can be used for both the DQPSK and OQPSK DS-SS modulation. The DQPSK differential encoding based on Telxon and UC Davis discussion [7, 13, 27, 28] is shown in Table.1.

Table 1. DQPSK/OQPSK Encoder

Dibit Pattern (d_0,d_1). d_0, first in time	Phase
00	0
01	$\pi/2$
11	π
10	$-\pi/2$

After the signal spectrum spreading, a half chip period staggering which can be turned on

by a computer software controlled switch, is carried out in the Q-channel data sequence. Therefore, the OQPSK DS-SS system is interoperable with the DQPSK DS-SS system. The baseband filters for the I and Q channels are the same for DQPSK, OQPSK, FQPSK, and DBPSK. For FQPSK DS-SS modulation, FQPSK processor [1,2,3,4] is used for OQPSK DS-SS with 1 watt class-C nonlinear amplifier. FQPSK is thus fully compatible with OQPSK.

The DQPSK, OQPSK, and the compatible FQPSK DS-SS system coherent demodulator is shown in Fig.2. In the demodulator, a corresponding half chip period delay in the I-channel signal, which can be switched on for OQPSK DS-SS, is used. The despreaded signals are then fed to the conventional coherent DQPSK demodulator as stated in the document of Telxon [28]. The demodulated data sequence is decoded by the differential decoder.

The spectrum of the DQPSK, OQPSK, and FQPSK DS-SS system are shown in Fig.3. The spectrum of DQPSK DS-SS with an 100 mw ideal linear power amplifier is shown for comparison. Since OQPSK has only 3dB envelope fluctuation, which is much smaller than the 7dB envelope fluctuation of the conventional DQPSK, OQPSK achieves a good spectral performance. With 1 watt NLA used, OQPSK DS-SS achieves -20.5dB power at 11MHz and -33.5dB at 22MHz with the conventional Square Root Raised Cosine LPF used, while DQPSK DS-SS only maintains -18.5dB at 11MHz, and -23.5dB at 22MHz. OQPSK DS-SS with FQPSK processor [1,2,3,4,21] achieves -33.5dB at 11MHz and -56.5dB at 22MHz, which satisfies the IEEE802.11 DS-SS PHY standard PSD requirement with a 1.5dB or more margin. Therefore, we recommend OQPSK as well as the fully compatible FQPSK as a solution for the application with 1 watt class-C NLA for the IEEE802.11 DS-SS PHY.
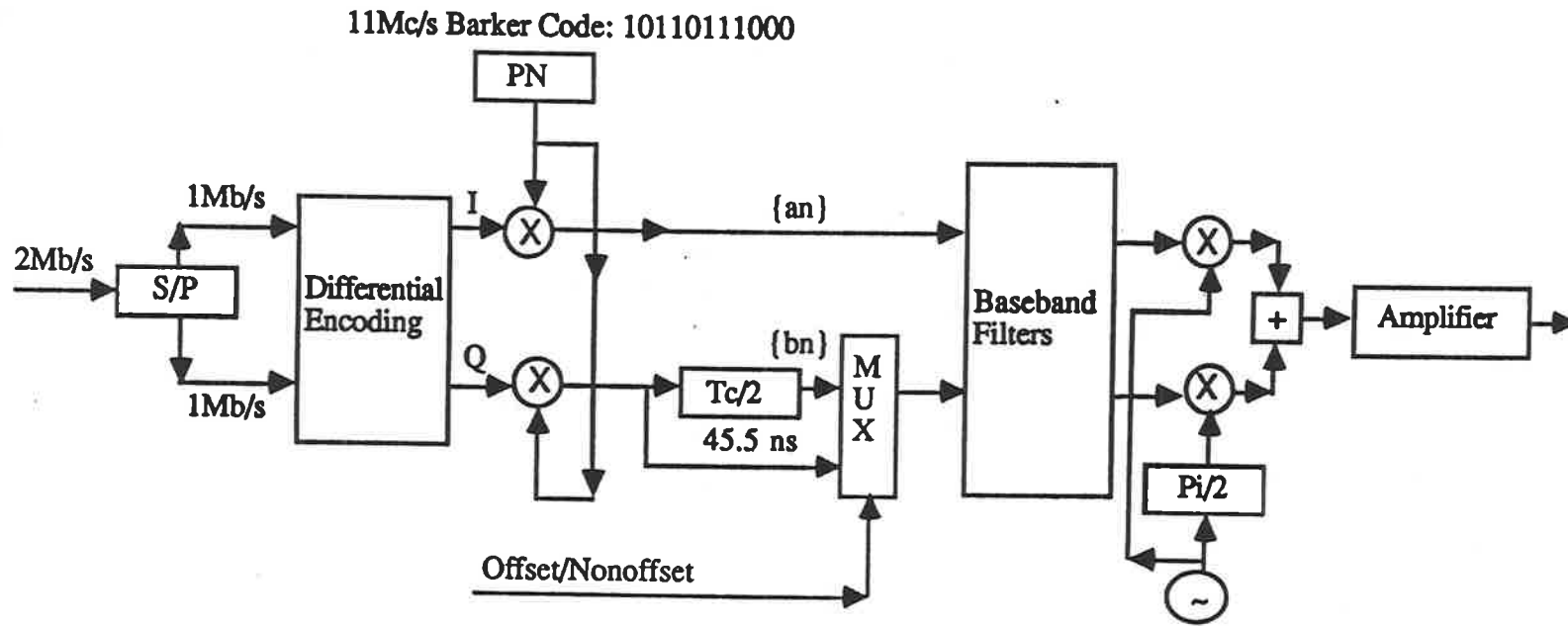
11Mc/s Barker Code: 10110111000

Fig.1 DS-SS Adopted Standard for 2Mb/s Rate DQPSK, Interoperable
OQPSK and Compatible Nonlinearly Amplified FQPSK
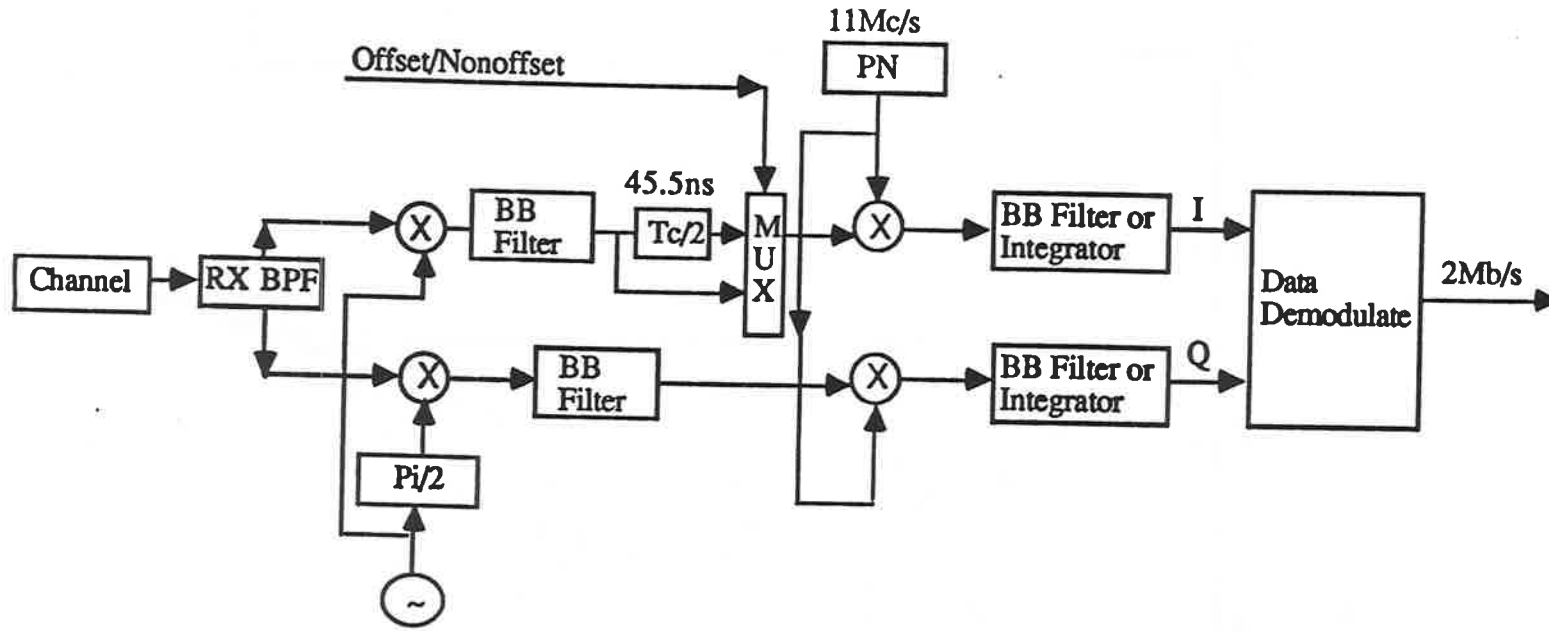------ Modulator Configuration

Fig.2 DS-SS Adopted Standard for 2Mb/s Rate DQPSK, Interoperable
OQPSK and Compatible Nonlinearly Amplified FQPSK
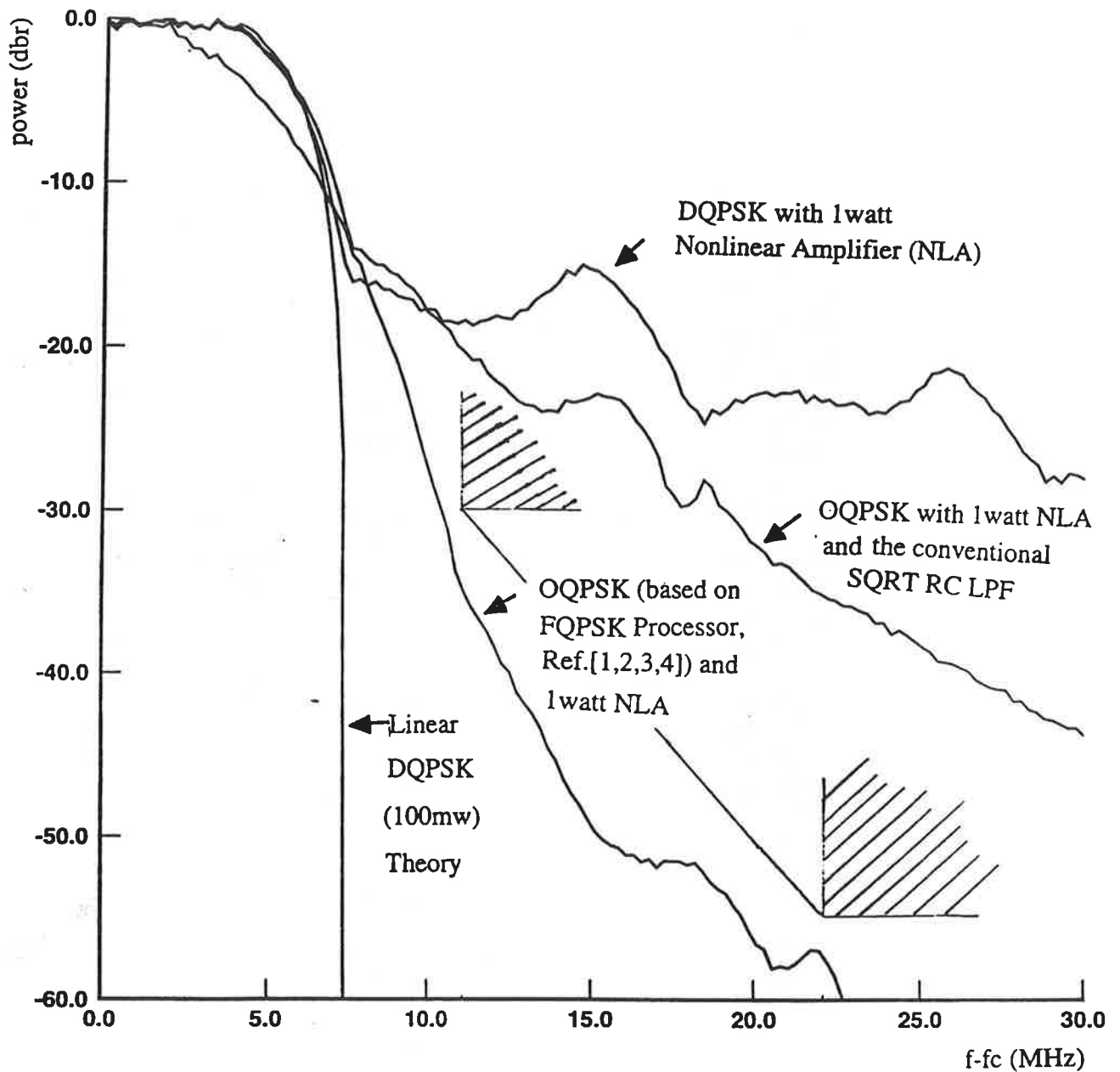------ Demodulator Configuration

Fig.3 Spectrum of DS-SS Signals with

(a) DQPSK with SQRT RC LPF, Alpha=0.35,
in the Ideal Linear Channel
(b) DQPSK with SQRT RC LPF, Alpha=0.35,
(c) OQPSK with SQRT RC LPF, Alpha=0.35,
(d) FQPSK in the Ideal Nonlinear Channel

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