IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 10, December 2014.
www.ijiset.com
ISSN 2348 – 7968

Study of MB-OFDM Transmitter Baseband System

Ms. Payal Kantute[1], Mrs. Jaya Ingole[2]

[1]Department of EXTC, PRMIT&R College of Engineering Badnera,
Amravati, Maharashtra, India.

[2]Associate Professor in PRMIT&R College of Engineering Badnera,
Amravati, Maharashtra, India.

Abstract

A multi-band orthogonal frequency division multiplexing (MB-OFDM) ultra wideband (UWB) system is being considered for the physical layer of the new IEEE wireless personal area network (WPAN) standard, IEEE 802.15.3a.The standard aims at the high data transmission rates of110 Mb/s over 10 meters, 220 Mb/s over 4 meters and 480Mb/s over 1 meter. In this paper introduction to the baseband blocks of MB-OFDM transmitter system and its major components is given.
Keywords : MB-OFDM,UWB,QPSK,IFFT.

1. Introduction

Multi-Band Orthogonal Frequency Division Multiplexing (MB-OFDM) [1,2] is a suitable solution to implementation of high speed data transmission in ultra wideband spectrum by dividing the spectrum available into multiple bands. MB-OFDM is a multi-carrier system where data bits are encoded to multiple sub-carriers, while being sent simultaneously. This results in the optimal usage of bandwidth. A set of orthogonal sub-carriers together forms an OFDM symbol. To avoid ISI due to multi-path, successive OFDM symbols are separated by guard band. This makes the OFDM system resistant to multi-path effects. The baseband of transmitter is one of the most important parts in MB-OFDM system. The structure of MB-OFDM system transmitter is introduced in this section. In recent years, UWB[3] communication systems have received significant attention from both the industry and the academia. In February 2002, the Federal Communications Commission (FCC) allocated 7,500 MHz of spectrum (from 3.1 GHz to 10.6 GHz) for use by UWB devices [4]. This ruling has helped to create new standardization efforts, like IEEE 802.15.3a [5], that focus on developing high speed wireless communication systems for personal area network.

2. Proposed Work and Objective

Structure of MB-OFDM Transmitter Baseband is –

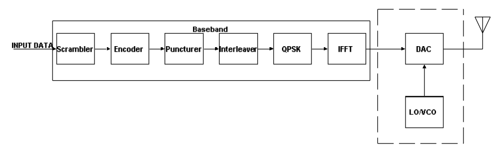

Fig. 1 MB-OFDM Transmitter Baseband

Basically we are implementing the digital baseband blocks of MB-OFDM transmitter [1] and its major components as follows & it is implemented with the help of VHDL code.
1] Scrambler 2] Encoder 3] Puncturer 4] Interleaver 5] QPSK 6] IFFT

1] Scrambler:

In telecommunications, a scrambler is a device that transposes or inverts signals or otherwise encodes a message at the transmitter to make the message unintelligible at a receiver not equipped with an appropriately set descrambling device.

Types of scramblers:

1. Additive (synchronous) scramblers :

Additive scramblers transform the input data stream by applying a pseudo-random binary sequence (PRBS) (by modulo-two addition). For the synchronous operation of the transmitting and receiving LFSR (that is, scrambler and descrambler), a sync-word must be us.Additive scrambler/descrambler is defined by the polynomial of its LFSR is ($\mathbf{1+x^{-14}+x^{-15}}$) and its initial state**.**

ISSN 2348 – 7968

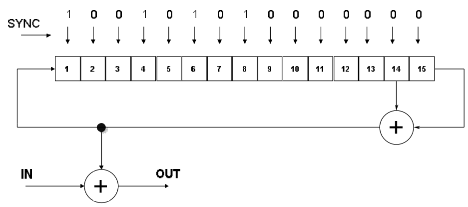

Fig. 2 Additive scramblers

2. Multiplicative (self-synchronizing) scramblers :

Multiplicative scramblers perform a multiplication of the input signal by the scrambler's transfer function in Z-space. They are discrete linear time-invariant systems. A multiplicative scrambler is recursive and a multiplicative descrambler is non-recursive.They do not need the frame synchronization, hence called self-synchronizing. Multiplicative scrambler/descrambler is defined similarly by a polynomial (for the scrambler in the figure it is ($1+x^{-18}+x^{-23}$)), which is also a transfer function of the descrambler.

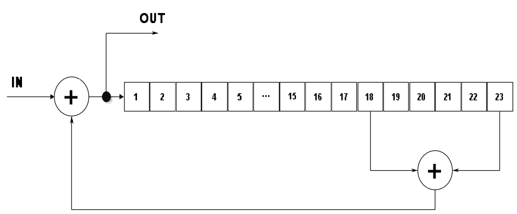

Fig. 3 Multiplicative scramblers

2] Encoder:

In telecommunication, convolution code is a type of error-correcting code in which each m- bit information symbol (each m-bit stream) to be encoded is transformed into an n bit symbol, where m/n is the code rate (n>m). The transformation is a function of the k information symbols. Here we have used convolutional encoder.

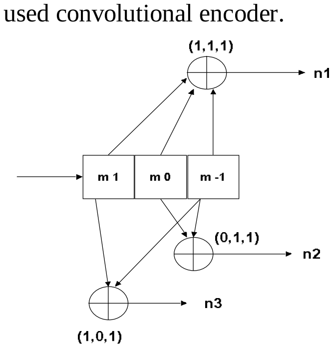

Fig. 4 Rate 1/3 non-recursive, non systematic convolutional Encoder with constraint length 3.

The Figure shown above is a rate 1/3 (m/n) encoder with constraint length (k) of 3. Generator polynomials are $G1$ = (1, 1, 1), $G2$ = (0, 1, 1), and $G3$ = (1, 0,1). Therefore, output bits are calculated (modulo 2) as follows:

1. $n1 = m1 + m0 + m\text{-}1$
2. $n2 = m0 + m\text{-}1$
3. $n3 = m1 + m\text{-}1$.

3] Puncturer:

Puncturing is the process of removing some of the redundant bits after encoding with an error-correction coding technique.Suppose L or NL bits of the output for convolutional encoder,the puncturing matrix P with NL symbols is defined as a binary array, where “1” denotes the data that is sent out and “0” denotes the data that is deleted. If P has m zeros, the code rate after puncturing is L/(NL-m), where $0 \leq m \leq (N-1)L$, L is the input of convolutional encoder.

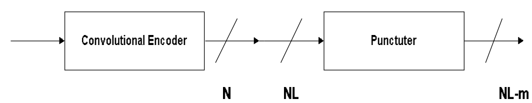

Fig. 5 Puncturer

4] Interleaver :

Interleaving is a process that makes a system more efficient, fast and reliable by arranging data in a noncontiguous manner.Also it is a device that rearranges the ordering of sequence of symbols in a deterministic manner.

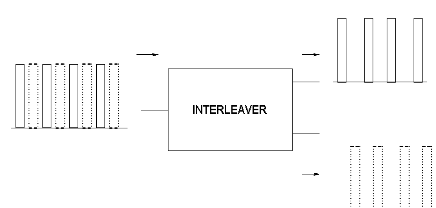

Fig. 6 Interleaver

5] QPSK:

QPSK uses four points on the constellation diagram, equispaced around a circle. QPSK is used to double the data rate as compared to BPSK.The coded and interleaved binary serial input data shall be divided into groups of two bits and converted into a complex number representing one of the four QPSK [6] constellation points.The conversion shall be performed according to the Gray-coded constellation mapping. The mapping relation of QPSK module is illustrated as in figure.

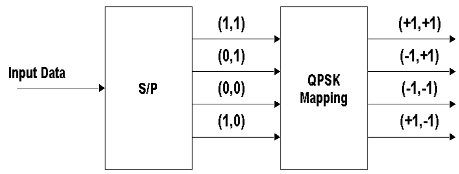

Fig. 7 QPSK Mapping

Writing the symbols in the constellation diagram in terms of the sine and cosine waves used to transmit them:

$$S_n(t) = \sqrt{\frac{2E_s}{T_s}} \cos\left(2\pi f_c t + (2n-1)\frac{\pi}{4}\right),$$

n = 1,2,3,4.

This results in a two-dimensional signal space with unit basis functions

$$\Phi_1(t) = \sqrt{\frac{2}{T_s}} \cos(2\pi f_c t)$$

$$\Phi_2(t) = \sqrt{\frac{2}{T_s}} \sin(2\pi f_c t)$$

The first basis function is used as the in-phase component of the signal and the second as the quadrature component of the signal.Hence, the signal constellation consists of the signal-space 4 points

6] IFFT:

IFFT is a core of the baseband of MB-OFDM transmitter. The bit streams will be modulated on various frequencies carrier by IFFT, initially carrier bank generating a set of subcarriers was necessary for OFDM in conventional or analogue approach. Each subcarrier was modulated with a constellation decided by bit combination, but this approach made system bulky and costlier. So to make system digital, simple, cheap, and efficient IFFT is being used. The N-Point IFFT [7] is shown in the figure below.

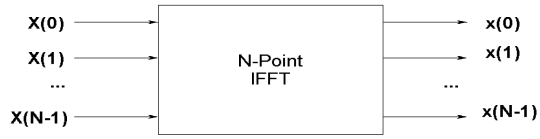

Fig. 8 N-Point IFFT

3. CONCLUSION

In this paper, an efficient way to design the IEEE 802 MB-OFDM transmitter is presented. We will use VHDL coding to design, each module of transmitter baseband for MB-OFDM .The paper presents about scrambler, encoder ,puncture, interleaver, QPSK and IFFT. This approach can also be used to design other high-speed communication systems or to improve their speed.

4. REFERENCES

[1] J. Balakrishnan, A. Batra, A. Dabak, A multi-band OFDM system for UWB communication, *IEEE Conference on Ultra Wideband Systems and Technologies*, 2003, pp. 354–358.

[2] A. Batra, J. Balakrishnan, A. Dabak, and et al, *MultiBand OFDM Physical Layer Proposal for IEEE 802.15.3a*, http://www.multibandofdm.org/presentations.html, MultiBand OFDM Alliance SIG, 2004.

[3] First report and order in the matter of revision of part 15 of the commissions rules regarding ultra-wideband transmission systems, Federal Communications Commission (FCC 02-48), std., ET Docket 98-153, Apr. 2002.

[4] Anuj Batra, et al., “Design of a Multiband OFDM System for Realistic UWB Channel Environments ”, IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. 52, NO. 9, SEPTEMBER 2004.

[5] ISO/IEC, “Information technology Telecommunications and information exchange between systems — High Rate Ultra Wideband PHY and MAC Standard”, 26907, Mar.2007, pp 15-59.

[6] ”Introduction to Quadrature Phase Shift Keying”. http://www.en.wikipedia.org/wiki/Phase-shift_keying

[7] M. Mohamed Ismail ,M.J.S Rangachar , Ch. D. V. Paradesi Rao “An Area Efficient Mixed-Radix

ISSN 2348 – 7968

4-2 Butterfly with Bit Reversal for OFDM Applications” Proposed processor architecture that can greatly save the area cost with high-speed .They also give detail analysis of several FFT algorithms such as radix-2, radix-4 and split radix are given.

[8] Wu Weiling,et,al. “Mobile Communication Principle”,Publishing house of electronics industry. Beijing, 2005,pp.161-170.

Ms. Payal Kantute
Department of EXTC, PRMIT&R College of Engineering Badnera, Amravati, Maharashtra.

Mrs. Jaya Ingole
Associate Professor in PRMIT&R College of Engineering Badnera, Amravati, Maharashtra.