The Parametric Analysis of Gaussian Pulse Shaping Filter in WCDMA Network

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Abstract

Digital Signal processing plays an important role in various researches in the field of WCDMA. Pulse shaping is a spectral processing technique for reduction of fractional out of band power causing low cost, reliable, power and spectrally efficient mobile radio communication system. WCDMA networks are facing the problems of ISI and channel bandwidth. In this present paper we are studying about different parameters of Gaussian pulse shaping filter which are affecting its performance.

Keywords WCDMA, Gaussian filter,

Introduction

The Third generation cellular systems are designed to provide the same quality of services as the fixed networks like video and high quality image transmission, high speed internet access etc. research efforts are running continuously for more than a decade for the introduction of multimedia capabilities into mobile communication [2]. Different standard agencies and governing bodies are putting their efforts to integrate a wide variety of proposals for 3G cellular systems.[9] One of the most striking approaches to 3G is to combine a Wideband CDMA (WCDMA) air interface with the fixed network of GSM. Several propositions supporting WCDMA were submitted to the International Telecommunication Union (ITU) and its International Mobile Telecommunications for the year 2000 (IMT2000) initiative for 3G. All these schemes try to take rewards of the WCDMA radio techniques without brushing off the numerous advantages of the already existing GSM networks. The standard that has come out is based on ETSI's Universal Mobile Telecommunication System (UMTS) and is commonly known as UMTS Terrestrial Radio Access (UTRA). UTRA uses Direct Sequence Code Division Multiple Access (DS-CDMA) as a prominent access scheme. The information spreads over a band of approximately 5 MHz. Presence of such wide bandwidth has given rise to the name Wideband CDMA or WCDMA. The future mobile systems should support multimedia services. A WCDMA system have higher capacity, better properties for scraping multipath fading, and greater flexibility in providing multimedia services with different transmission rate and different QoS requirements and has been investigate worldwide. CDMA mobile systems are interference limited and therefore reduction in interference can directly increase system capacity. [8]

WCDMA

The WCDMA air interface, referred also as UMTS terrestrial radio access (UTRA), developed by the third-generation partnership project (3GPP). 3GPP has the goal to accord and standardize in detail the similar proposals from ETSI, ARIB, TTC, TTA, and T1. WCDMA has two modes of operation which are characterized by the duplex method: FDD (frequency division duplex) and TDD (time division duplex), for operating with paired and unpaired bands, respectively.[1] The chip rate for the WCDMA system is 3.84 Mcps . The frame length is taken to be 10 ms and each frame is divided into 15 slots (2560 chip/slot at the chip rate 3.84 Mcps). In WCDMA, Spreading factors range from 256

to 4 for the uplink and from 512 to 4 for downlink. Thus, the respective modulation symbol rates vary from 960 k symbols/s to 15 k symbols/s (7.5k symbols/s) for FDD uplink. For separating channels from the same source, orthogonal variable spreading factor (OVSF) channelization codes are used. In the downlink, to separate different cells Gold codes with a 10 ms period (38400 chips at 3.84 Mcps) are used, with the actual code itself of 218-1 chips. In the uplink, either Gold codes with a 10- ms period, or short codes with a 256-chip period, are used to separate the different users.[1]

Pulse Shaping In WCDMA Networks

Linear modulation methods such as QAM, QPSK, and OQPSK are getting much attention due to their inherent high spectral Efficiency. However for the efficient illustration of transmitted signal, the Radio Frequency Amplifier is normally operated near the saturation region and therefore exhibit non linear behavior. When a signal with large envelope variations propagates through such an amplifier and creates large envelope fluctuations, which results in substantial spectral spreading.[5]

To satisfy the ever increasing demands for higher data rates as well as to allow more users to simultaneously access the network, interest has peaked in what has come to be known as wideband code division multiple access (WCDMA). The basic characteristics, of WCDMA waveforms which make it attractive for high data rate transmissions, are their advantages over other wireless systems. It accentuates that how the choice of spread bandwidth affects the bit error rate of system.[6]

In communications systems, two crucial requirements of a wireless communications channel demand the use of a pulse shaping filter. These prerequisites are:

a) Generating band limited channels, and b) Reducing Inter Symbol Interference (ISI) arising from multi-path signal reflections. [7]

Examples of pulse shaping filters which are commonly found in communication systems are:

- Rectangular pulse
- Raised Cosine Pulse
- Square root raised cosine filter
- Gaussian Pulse
- Flipped Exponential Pulse
- Flipped Hyperbolic Secant Pulse
- Flipped Inverse Hyperbolic Secant Pulse

Gaussian Pulse Shaping Filter

Gaussian filter is a filter whose impulse response is a Gaussian function. Gaussian filters are designed to give no overshoot to a step function input while minimizing the rise and fall time. It has the minimum possible group delay. It is used as a smoother because of this being a linear filter. Gaussian filter is used in GSM since it uses GMSK modulation. It is also used in GFSK and Canny Edge Detector used in image processing.[7]

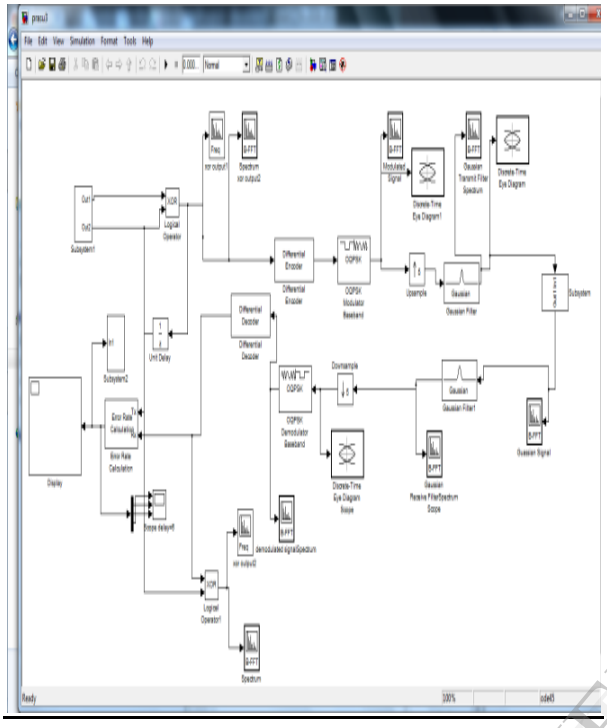
Mathematically, a Gaussian filter modifies the input signal by convolution with a Gaussian function; this transformation is also known as Weierstrass transform. The Gaussian filter is non causal which means the filter window is symmetric about the origin in time domain. No amount of delay can make a Gaussian filter causal, because the Gaussian function is never zero. The FIR Gaussian pulse shaping filter design is done by truncating a sampled version of the continuous time impulse response of the Gaussian filter which is given by:

$$h(t) = \frac{\sqrt{\pi}}{a}\ e^{-\frac{\pi^2 t^2}{a^2}}$$

The parameter 'a' is related to 3- dB bandwidth symbol time product (BT_S) of the Gaussian filter as given by:

$$a = \frac{1}{BT_s}\frac{\sqrt{\log 2}}{\sqrt{2}}$$

Simulation Model



Analysis of Gaussian filter By Variation of Different parameters-

1) Variation of BT_S Product

Here we are analyzing the BER at D= 6, and N=12.

S. No.	BT_S Product	Bit Error Rate
1.	0.11	0.51125
2.	0.22	0.49575
3.	0.33	0.49175
4.	0.44	0.49175

2) Variation of group Delay (D)

Here we are analyzing the BER at BT_S= 0.33, and N=12. Here we are taking the value of BT_S to be 0.33 because we are getting the minimum BER For it.

S. No.	Group Delay	Bit Error Rate
1.	2	0.5045
2.	4	0.49175
3.	6	0.49175
4.	8	0.52075

3) Variation of Input samples per symbol (N)

Here we analyzing the BER at BT_S = 0.33 and D= 6, as per our previously obtained results.

S. No.	Input Samples per Symbol	Bit Error Rate
1.	6	0.5125
2.	8	0. 50375
3.	12	0.49175
4.	16	0.52075

Conclusion

In this paper Gaussian pulse shaping filter has been analyzed for WCDMA at 5MHz. the variation of BT_S product, group delay(D) and Input Samples per Symbol (N) have been studied. It is seen, from the analysis of above tables, that we are getting the minimum amount of BER for D= 6, N= 12, and BT_S = 0.33. As group delay is increased from 4 to 8, BER also increases. Hence it is necessary for RF Design engineer to select the optimum value of group delay to decrease the complexity of the filter.

Impact of the study

The study is useful in improvement of the performance of WCDMA network.

1. In planning of WCDMA network.

2. In designing of future cellular mobile communication network.

3. In achieving the flexibility for the use of data rates in different environments.

4. The proposed WCDMA Simulator can be used for optimization of parameters in various environments, with various mobile disseminations and dissimilar services.

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