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TMS320C6713DSP IMPLEMENTATION OF PULSE SHAPING FILTER

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Abstract

One of the most challenging issues facing deployment of 3G technology is how to make the network architectures compatible with each other. New signaling techniques are being designed specially to enhance today's networks, deliver unprecedented functionality for 3G, and successfully derive the future generation of wireless systems, thus delivering immediate and long term benefits to subscribers. With the architecture of each generation of wireless devices addressed in the development of advance technologies, subscribers can easily evolve their systems without additional network modification, significantly reducing cost and implementing time. The next generation systems based on the DS-CDMA, FDMA/TDMA and GSM concepts are projected to provide transmitting high speed data, video and multimedia traffic for both indoor and outdoor systems, new technologies like Wideband Code Division Multiple Access (WCDMA), already in service, are providing users with high data rate services options like they have never experienced previously. The present paper deals with DSP Implementation of pulse shaping filter for wireless communication.

Keyword: DSP, WCDMA, Pulse Shaping, AWGN, DSK, FFT

1. Introduction

The First Generation (1G) and Second Generation (2G) of mobile telephony were indented for voice transmission. The Third Generation (3G) is meant for both voice and data applications[H.Holma,2002]. The thirst for effective communication and higher bandwidth has led to the evolution of the next generation wireless systems, and newer technologies are being deployed to provide the user with information and entertainment anywhere and anytime [Tero Ojanpera and Ramjee Prasad,2001]. The third generation mobile radio systems (IMT-2000 globally and UMTS in Europe) are becoming a reality today. The network infrastructure is currently being

deployed in many countries[Richard C Kirby,1999]. Manufacturers, network operators and service providers are now focusing on the development of new services and applications as well as suitable business models to make third generation mobile communication an economic success[Tero Ojanpera and Ramjee Prasad,1998]. One important lesson to be learnt from the development of 3G is that the potential future services and applications, including the expected user behavior should be taken into account from the very beginning to derive the technical requirements. This approach is essential to enable the economic success of future system [Keiji Tachi Kawa,Wiley 2002].

2. WCDMA-A Wireless Air Interface Access Technology

Wideband Code Division Multiple Access (WCDMA) technology has emerged as the most widely adopted 3G air interference. Its specification has been created in the 3rd Generation Partnership Project (3GPP), which is the joint standardization project of the standardization bodies from Europe, Japan, Korea, the USA and China [Rulph Chassing and Donald Reay,2004]. WCDMA is considered to be wideband technologies based on the direct sequence spread spectrum transmission scheme, where user information bits are spread over a wide bandwidth by multiplying the user data with quasi-random bits called chips derived from CDMA spreading codes. In order to support very high bit rates (upto 2 Mbps), the use of a variable spreading factor and multicode connection is supported. The chip rate 3.84 Mcps used to leads a carrier bandwidth of approximately 5 MHz. The relatively high bandwidths occupied by CDMA systems are responsible for the significant advantages of CDMA over traditional narrowband systems.

1. The spread of information over a very high bandwidth causes the CDMA signal to have power levels comparable to those of the noise floor. This guarantees high resistance to jamming and lower intercept probability.
2. The high bandwidth also ensures inherent resistance to multipath which causes significant signal attenuation in narrowband systems.
3. The soft handoff ensures that there are fewer “dropped” calls as the mobile moves from one cell to another.
4. The interference added by each user in the system can be considered as AWGN by the others. The whole system can therefore be designed using the average interference conditions. The ability to use the same set of frequencies within each cell results in an increase in the capacity of CDMA systems as compared to TDMA/FDMA systems.

5. The wide carrier bandwidth of WCDMA supports high user data rates and increased multipath diversity. Each user is allocated frames of 10 ms duration, during which the user data rate is kept constant [45]. However, the data capacity among the users can change from frame to frame as shown in Figure (2.6).

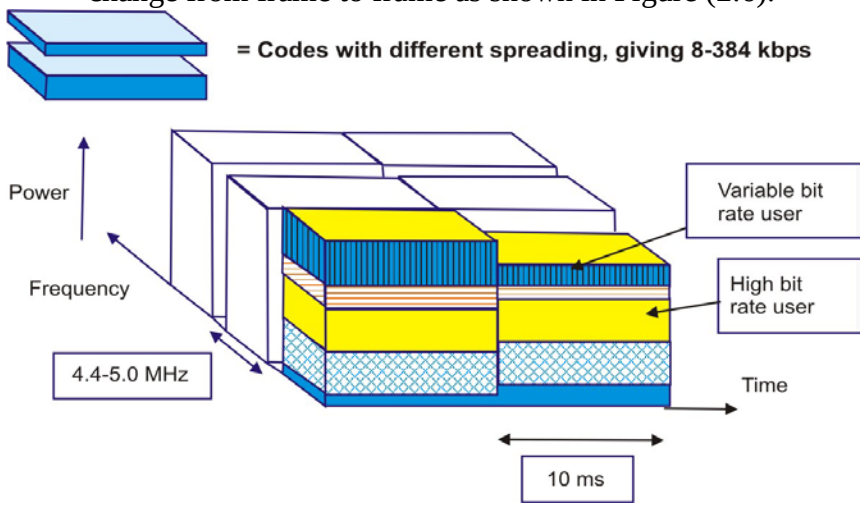


Figure 1. Allocation of Bandwidth in WCDMA in the time–frequency code space [9]

3. Pulse Shaping in Wireless Communication

Pulse shaping is a spectral processing technique by which fractional out of band power is reduced for low cost, reliable , power and spectrally efficient mobile radio communication systems. It is clear that the pulse shaping filter not only reduces intersymbol interference (ISI), but it also reduces adjacent channel interference.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 that make them attractive for high data rate transmissions are their advantages over other wireless systems. It emphasizes that how the choice of spread bandwidth affects the bit error rate of system [Rulph Chassing and Donald Reay,2004]The design and analysis of transmit and receive pulse shaping filter is an important aspect of digital wireless communication since it has a direct effect on error probabilities.The pulse shaping digital filter is a useful means to shape the signal spectrum and avoid interference. Basically digital filters are used to modify the characteristics of signal in time and frequency domain and have been recognized as primary digital signal processing operations.In the radio environment, transmitted signals arrive at the receiver via a direct, unobstructed path, or via multiple paths from the reflection, diffraction and scattering of surrounding objects such as buildings and trees. This multipath propagation causes the signal at

the receiver to distort and fade significantly, leading to inter-symbol interference (ISI). Pulse sahping digital filters plays a crucial role in controlling the group delay in WCDMA [A.S.Kang and Vishal Sharma,IEEE RUSSIA,2009].

Keeping in view the need of enhancement of WCDMA performance, the present study aims on DSP implimentations of digital pulse shaping filter under different conditions. The figure 2 shows the role of pulse shaping transmit and receive filter in wireless communication.

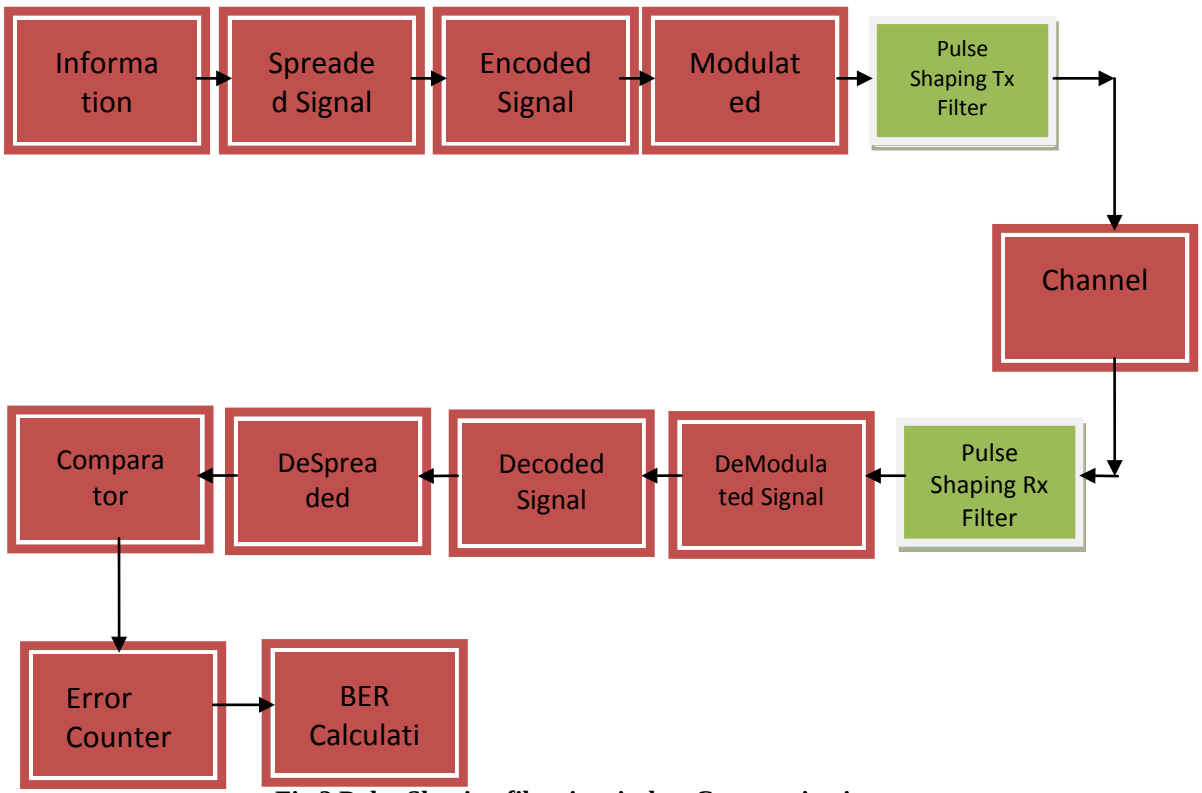


Fig 2 Pulse Shaping filter in wireless Communication

4.DSP Platform

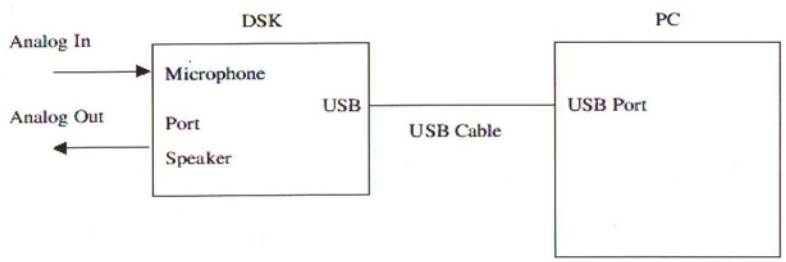
Digital signal processor are used for a wide range of applications, from communications and control to speech and image processing. They are found in cellular phones, fax/modems, disk drivers, radios, printers, hearing aids, MP3 players, HDTV, digital cameras, and so on. Specialized (particularly in terms of their on board peripherals) DSPs are used in electric motor drives and a range of associated automotive and industrial applications. Overall, DSPs are concerned primarily with real-time signal processing. DSPs tend to have low power consumption requirements. This attribute has been extremely important in establishing the use of DSPs in

cellular handsets [A.S.Kang and Vishal Sharma,2008] The Texas instrument TMS320C6713 is a digital signal processing starter kit and is a low cost development platform for real –time digital signal processing applications. It comprises a small circuit board containing a TMS 320C6713 floating –point digital signal processor and a TLV320AIC23 analog interface circuit (codec) and connects to a host PC via a USB port. PC software in the form of code composer studio(CCS) is provided in order to enable software written in C or assembly language to be compiled or assembled, linked and downloaded to run on the DSK.

5. DSK Support Tool

The figure 3 shows the signal processing configuration using C6713DSK.The following tools are used to the study on the performance analysis the parameters under investigation [A.S.Kang and Vishal Sharma,2008]

Figure 3 Signal processing configuration using C6713 DSK



1.A Texas instrument DSP starter kit (DSK). The DSK package includes:

a) Code composer studio (CCS), which provides the necessary software support tools. CCS provides an integrated development environment (IDE), bringing together the C compiler, assembler, linker, debugger, and so on.

b) A circuit board (the TMS320C6713 DSk is shown in figure.) containing a digital signal processor and a 16 bit stereo codec for analog signal input and output.

c) A universal synchronous bus(USB) cable that connects the DSk board to a PC.

d) A +5 V universal power supply for the DSk board.

1. A PC. The DSk board connects to USB port of the PC through the USb cable included with the DSk package.
2. An oscilloscope, spectrum analyzer. Signal generator, headphones, microphone, and speakers.

TMS 320C6713 is based on very long instruction word(VLIW) architecture which is very well suited for numerically intensive algorithms.The figure 4 shows the TMS320C6713-based DSK board: (a) board and (b) block diagram.

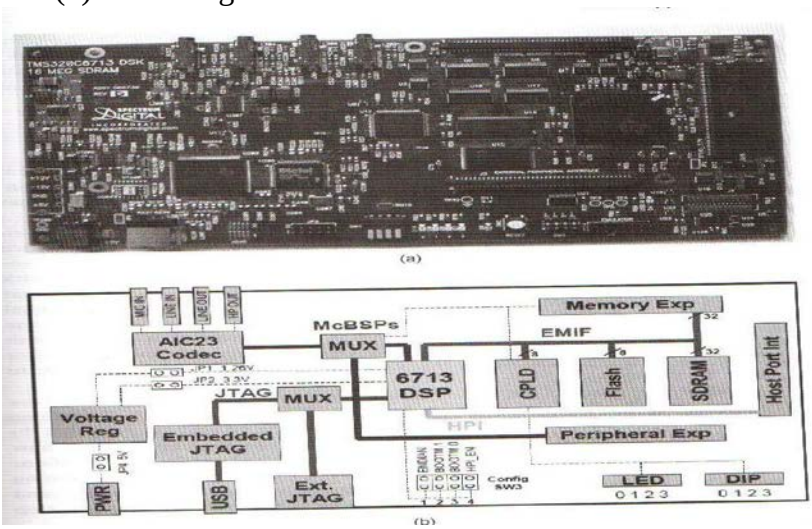


Figure 4.The TMS320C6713-based DSK board: (a) board and (b) block diagram.

6. Code Composer Studio (CCS)

Code composer studio (CCS) provides an integrated development environment (IDE) for real time digital signal processing applications based on the c programming. It incorporates a C compiler, an assembler, and a linker. It has graphical capabilities and supports real-time debugging.The C compiler compiles a C source program with extension .c to produce an assembly source file with extension .asm. The assembler assembles an .asm source file to produce a machine language object file with extension .obj. the linker combines object files and object libraries as input to produce an executable file with extension .out. This executable file represents a linked common object file format (COFF), popular in unix –based systems and adopted by several makers of digital signal processors. This executable file can be loaded and run directly on the digital signal processor. A Code composer studio (CCS) project comprises all of the files (or links to all of the files) required in order to generate an executable file [A.S Kang and Vishal Sharma,2008]

7. Results

Square Root Raised Cosine filter has been analysed for WCDMA at 5Mhz.The effect of variation of roll off factor, group delay and interpolation factor have been studied.[A.S.Kang and Vishal Sharma, Institution of

Engineers,2008] The simulation model has been built for square root raised cosine filter in which the information is of 64 kbps data rate for WCDMA at 5 MHz with different values of group delay. The value of group delay D=6 is found to be optimum for better performance of pulse shaping filter in terms of bit error rate for WCDMA based wireless communication system[A S Kang and Vishal Sharma, IJOAT USA,2010].

Real-time analysis can be performed using CCS's real-time data exchange (RTDX) facility. This allows for data exchange between the host PC and the target DSK as well as analysis in real-time without halting the target. The figure 5 and 6 show the graphical display of code composer studio. The time response and FFT magnitude and phase response of pulse shaping filter.

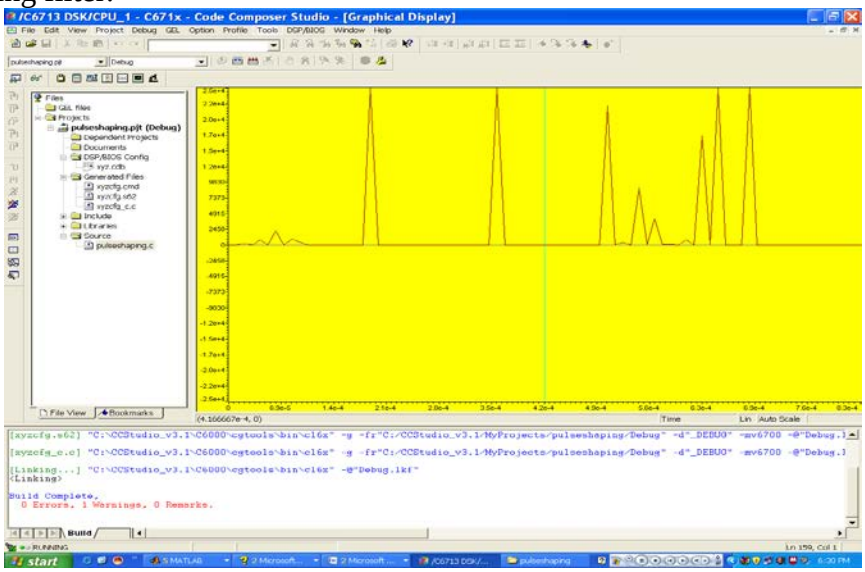


Figure 5. The time response of code composer studio

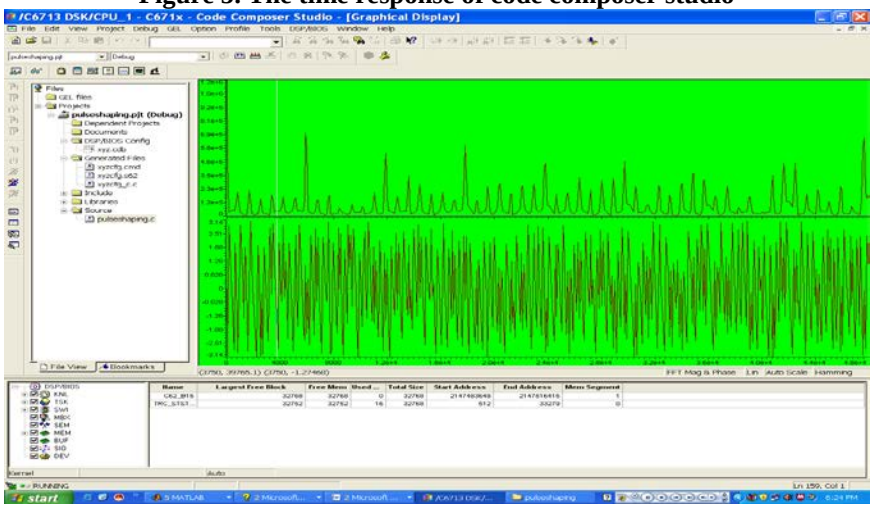


Figure 6 The FFT magnitude and phase response of pulse shaping filter

The Figure 7 shows the FFT magnitude and Phase with 16 bit signed integer with Hamming window at 96000 Hz sample rate with Group Delay (d)=20, Interpolation factor (m)=2, Roll Off factor (alpha)=.22 ,filter length =81.

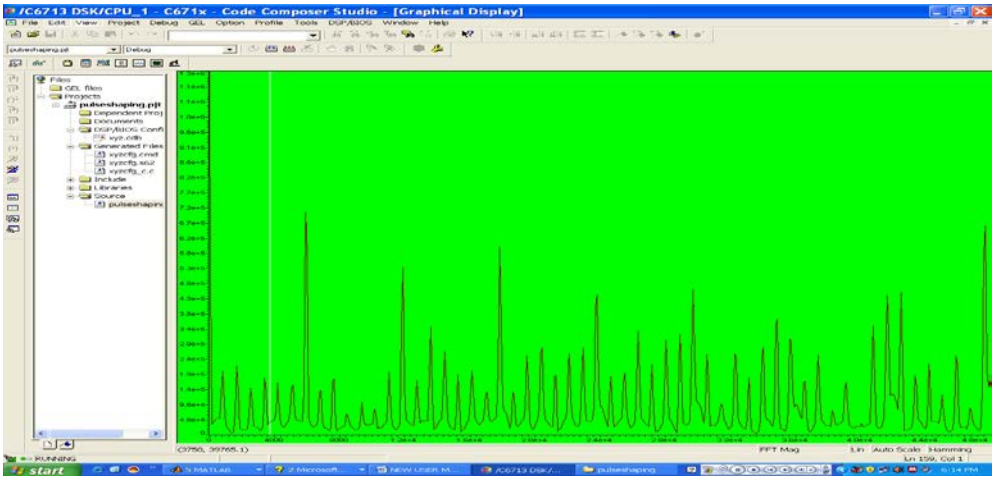


Figure 7 TMS320C6713 DSK KIT RESULTS FOR FFT magnitude and Phase with 16 bit signed integer with Hamming window at 96000 Hz sample rate with Group Delay d=20, Interpolation factor m=2, Roll Off factor alpha=.22, Filter length 81

8.Conclusion:

The application of signal processing techniques to wireless communications is an emerging area that has recently achieved dramatic improvement in results and holds the potential for even greater results in the future as an increasing number of researchers from the signal processing and communication areas participate in this expanding field. Due to intensive use of FIR filters in video and communication systems, high performance in speed, area and power consumption is demanded. W-CDMA can support mobile/portable voice, images, data, and video communications at up to 2 Mbps (local area access) or 384 Kbps (wide area access). The input signals are digitized and transmitted in coded, spread-spectrum mode over a broad range of frequencies. A 5 MHz-wide carrier is used, compared with 200 kHz-wide carrier for narrowband CDMA. The group delay plays a crucial role in pulse shaping digital finite impulse response filter [A.S.Kang and Vishal Sharma,IJACSA USA,2011]. The value of group delay should be minimum for efficient performance of digital pulse shaping filter. The implementation of pulse shaping filter using Digital Signal Processing Kit has also been attempted using Code Composer Studio [White Paper,National Instruments,2013].

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