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Design & Implementation of Digital up Converter for Wcdma System

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Abstract:- Wideband Code Division Multiple Access (WCDMA) is 3rd generation technology for wireless communications. Digital up converter (DUC) is integral part of WCDMA. In this thesis, DUC for WCDMA system is designed. The DUC is designed in MATLAB. The proposed DUC design consists of WCDMA system and up conversion filters. Up conversion system consists of pulse shaping filter (Root Raised Cosine) and three halfband filters. RRC filter has a interpolation factor 2. Halfband filters are a type of Finite Impulse Response (FIR). Hence the signal is upsampled by a factor of 16.
The result shows the up converted signal at 5 MHz bandwidth, up sampled with the rate of 16 with the upsampling frequency of 61.44 MSPS. ACLR and EVM values are obtained.

Keywords:- Digital up converter (DUC), Finite Impulse Response filter (FIR) , Wideband Code Division Multiple Access (WCDMA), Root Raised Cosine (RRC) Intermediate Frequency (IF).

I. INTRODUCTION

In modern technology , DUCs are widely used in digital signal processing algorithms due to their small size, low power consumption and accurate performance. The DUC converts the signal at the output of digital to analog convertor (ADC), centered at complex baseband signal to the IF. In this paper, the DUC for the WCDMA system is discussed and implementes in the Matlab. WCDMA is a leading choice of data communication in the wireless industry nowadays and is selected as the air interface for the UMTS. WCDMA supports a higher data rate and is less susceptible to narrowband interferers and multipath. [5]

II. SYSTEM REQUIREMENTS

DUC must be designed to satisfy the 3rd generation partnership project (3GPP) specification which defines the transmission and reception required for base station radio of WCDMA.

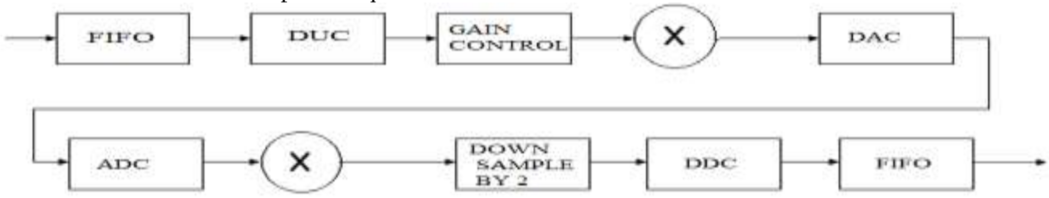

Fig 1 Front end block diagram for WCDMA

DUC is an integral part of a communication system, used to convert the sample rate of the signal. DUCs typically include frequency shifting using mixers. The structure of a DUCs mainly on the conversion ratio. For WCDMA systems, the conversion ratio is typically in the order of 8. Fig 2 shows the top level front end lock diagram of WCDMA.[3]

Table 1. Specification for downlink receiver path[1]

Parameters	Values
Input signal quantization	14 bits
Output signal quantization	16 bits I & Q
Mixer properties	Tunability: Variabile
IF sample rate	61.44 MCPS
No. of carriers	1
Carrier bandwidth	5 Mhz
DDC output rate	7.68 MSPS

III. DUC DESIGN

The DUC provides pulse shaping, interpolation, and frequency translation to the single-carrier baseband WCDMA signal from 0 Hz to a set of specified center frequencies. It is designed to meet the 3GPP TS 25.104 specification, which defines the transmission and reception requirements for the base station radio. Basic diagram of DDC is shown in fig 2.

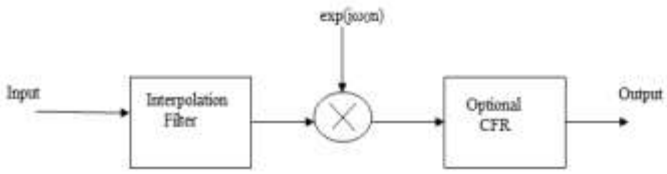

Fig 2 Basic diagram of DUC

A DUC is a digital circuit which converts a digital baseband signal to a passband signal. The input baseband signal is sampled at a relatively low sampling rate, typically the digital modulation symbol rate. The baseband signal is filtered and converted to a higher sampling rate before modulating a direct digitally synthesized (DDS) carrier frequency.

The input signals are passed through four filtering stages. Each stage first filters the signals with a pulse shaping RRC filter and then performs a sampling rate change. The DUC is a cascade of three halfband filters and one RRC filter. The RRC is a pulse shaping filter that increases the sampling rate by 2 and performs transmitter Nyquist pulse shaping.

The filters are implemented in fixed-point mode. The input/output word length and fraction length are specified. The sample rate change from 3.84MSPS to 61.44 is done. The designed model of DUC is shown in fig. 3.

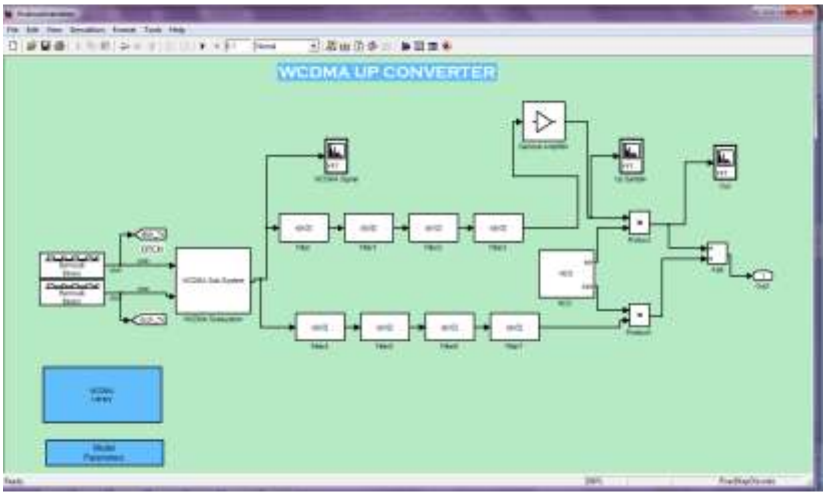

Fig 3 DUC Model Design Using Matlab

IV. RESULTS

The DUC is designed using Matlab. The following results are concluded.

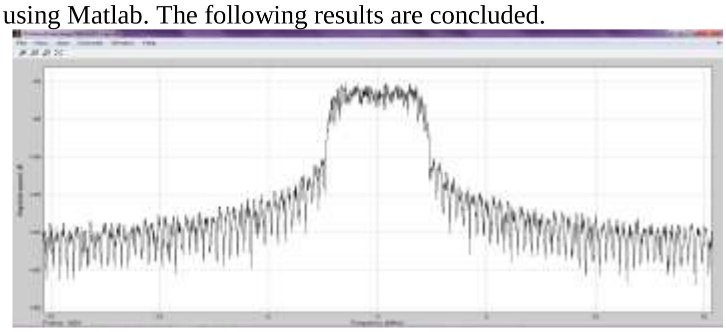

Fig 4 Input signal or WCDMA waveform

The input signal of DUC is shown in fig4 .The input DUC is a 1 carrier WCDMA composite signal whose total power is set at the level of 70 db below the desired signal.

In statistical signal processing, the goal of spectral density estimation is to estimate the spectral density (also known as the power spectrum) of a random signal from a sequence of time samples of the signal. Intuitively speaking, the spectral density characterizes the frequency content of the signal. The purpose of estimating the spectral density is to detect any periodicities in the data, by observing peaks at the frequencies corresponding to these periodicities.

SDE should be distinguished from the field of frequency estimation, which assumes a limited (usually small) number of generating frequencies plus noise and seeks to find their frequencies. SDE makes no assumption on the number of components and seeks to estimate the whole generating spectrum.[8]

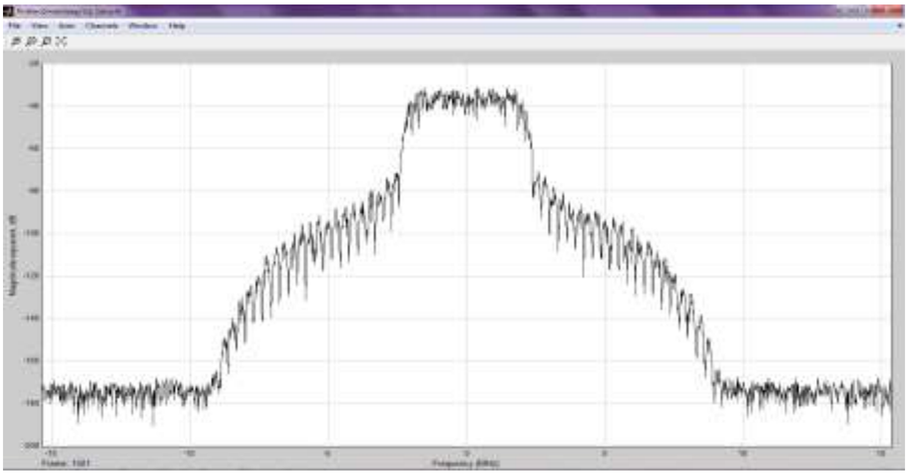

Fig 6 Output of DUC

The output of DUC is shown in fig. 6. This window estimates the power consumption with the frequency . The power consumption has been estimated in terms of db and the frequency has been estimated in terms of MHZ.The maximum power attained by this system is -65 dbm.

V. CONCLUSIONS

According to WCDMA standards, WCDMA systems can be designed for channel bandwidth 5 MHz. As higher bandwidth can lead to more data rate and also design of digital systems at large bandwidth is of great challenge. So, in this paper interpolator stages of WCDMA DUC is designed for 5 MHz bandwidth. So, the design of WCDMA DUC results in an efficient system. The various parameters are evaluated after simulating the design. EVM factor evaluates the modulation quality of transmitter. The measured RMS EVM value is 8.01%. The ACLR values for offset frequency 5MHz and 10MHz are obtained.

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