www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 3 Issue 7 July, 2014 Page No. 7242-7246

A Multichannel Multimode RF Transceiver With DSM

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Abstract: Wireless communication is a communication between more than one points without the use of any interconnection networks. It permits the long range communication. The best example of wireless communication is radio system. In early days most of the systems transmit the analog signals. But now a days ,radio systems transmit the digital datas composed of binary bit streams which are obtained directly from the signals or by digitizing the analog signals. The architecture used in this type of communication is multimode multichannel RF transmitter and receiver using Delta sigma modulator. This paper deals about the single channel and multichannel transmitter sections .These two architectures are implemented using VHDL programming language.

Keywords: *Delta-sigmaModulator(DSM),RFfilter,RF Transmitter, RF receiver.*

1.Introduction

Wireless communication is the transfer of information between two or more points that are not connected by an electrical conductor. Transmission is the process of sending and propagating an analogue or digital information signal over a physical point-to-point or point-to-multipoint transmission medium, either wired, optical fiber or wireless. The most common wireless technologies use radio. With radio waves distances can be short, such as a few meters for television or as far as thousands or even millions of kilometers for deep-space radio communications. Information, such as sound, is carried by systematically changing (modulating) some property of the radiated waves, such as their amplitude, frequency, phase, or pulse width. Each system contains a transmitter. This consists of a source of electrical energy, producing alternating current of a desired frequency of oscillation. The transmitter contains a system to modulate (change) some property of the energy produced to impress a signal on it. This modulation might be as simple as turning the energy on and off, or altering more subtle properties such as amplitude, frequency, phase, or combinations of these properties. The transmitter sends the modulated electrical energy to a tuned resonant antenna; this structure converts the rapidly changing alternating current into an electromagnetic wave that can move through free space. An antenna (or aerial) is an electrical device which converts electric currents into radio waves, and vice versa. The radio equipment involved in communication systems includes a transmitter and a receiver, each having an antenna and appropriate terminal equipment such as a microphone at the transmitter and a loudspeaker at the receiver in the case of a voice-communication system. In radio communications, a radio receiver is an electronic device that receives radio waves and converts the information carried by them to a usable form.

2.Existing System

Existing technology, presented the architecture and implementation of an all-digital transmitter with radio frequency output targeting an FPGA device. FPGA devices have been widely adopted in the applications of digital signal processing (DSP) and digital communication .Also many researches have published works in the area of digital RF signal generation. However, only simulation results or non real-time test results have been presented. In these works, the digital RF signals were computed offline and stored in pattern generator for the purpose of measurement. The use of BPDS modulation to generate binary signals in the RF range has been first presented. The drawback of this architecture is that the BPDS modulator needs to be running at 4 times the output center frequency. This high frequency typically lies in the giga-hertz range. Thus the implementation of transmitter becomes a very difficult task (nearly impossible) using current FPGA devices (or any programmable device). To accomplish such high frequency of operation, customized integrated circuits have to be carefully designed .So in this paper using the low pass delta sigma modulator for the designing of transmitter and receiver sections.

2.1Disadvantages

- Single channel transmission hence not a better utilization of the radio spectrum.
- The remaining architectures all fail to transmit two or more different carriers at a time.
- Transmitters are only able to generate low RF frequencies or require external multiplexers for enabling carriers operating in the gigahertz frequency range.

3.Single Channel Transmitter

Fig. 1 presents the architecture of a $\sum\Delta$ based all-digital transmitter. Such an architecture uses low-pass $\sum\Delta$ modulators operating at the sampling frequency fs to generate the bi-level outputs vi and vq from the baseband In-phase (I) and Quadrature (Q) data respectively. The three multiplexers are then used to digitally up-convert and mix the bi-level vi and vq signals for in order to generate an RF output signal.

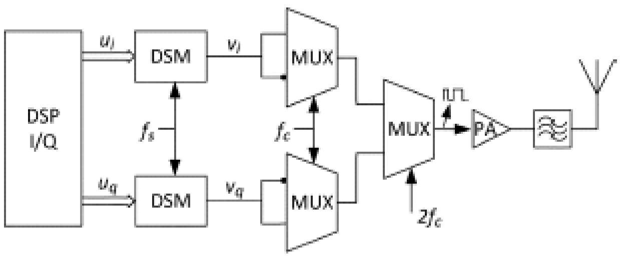

Figure 1:Single channel transmitter.

Here present digital transmitters identical to the presented architecture. However, current state-of-the-art all-digital transmitters are still very restrictive for supporting multichannel data transmission. The simulation results for a dual-band transmitter using modulators clocked at a frequency of several GHz, which is very hard to implement using current technology. The remaining architectures all fail to transmit two or more different carriers at a time. Moreover, such transmitters are only able to generate low RF frequencies or require external multiplexers for enabling carriers operating in the gigahertz frequency range.

4.Multichannel Transmitter

Fig.2 is the $\sum\Delta$-based architecture that extends previous work by adding the following two main contributions: a) it enables the simultaneous transmission of multiple carriers with different standards, frequencies, modulations and spectral masks, and b) it provides an integrated solution where the digital up-conversion to RF operating in the gigahertz frequency range and the multichannel capacity are embedded into a single device, such as a Field-Programmable Gate Array (FPGA).

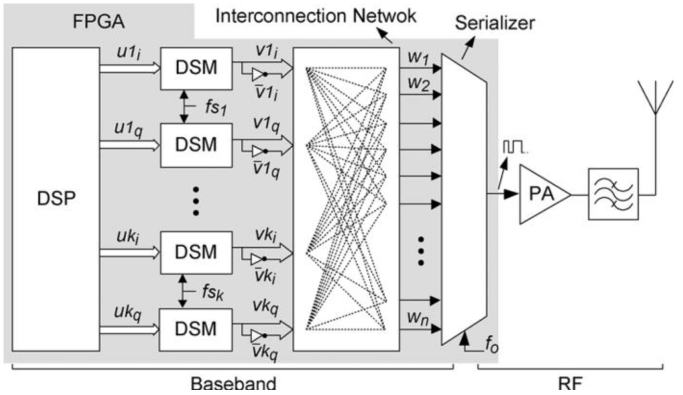

Figure 2: Multichannel transmitter.

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4.1Advantages

- It enables the simultaneous transmission of multiple carriers with different standards, frequencies, modulations.
- It enables efficient radio spectrum utilization.
- Fast switching of carrier frequencies improve jamming robustness.
- Automatically detect and exploit unused spectrum.
- Automatically detect and interoperate with varying network standards.
- Improve performance.

4.2 Delta Sigma Modulator(DSM)

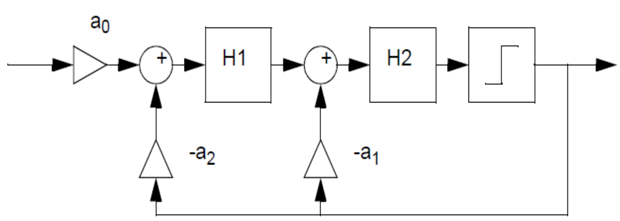

Figure 3: Delta sigma modulator.

There are a lot of different ways to realize a sigma-delta modulator. At first we looked at the structure in figure 3. It has some advantages, for example the ability to spread the position of the zeros, which in our case could have been interesting since in this study Ericsson also cares about the out of band noise. This structure however would be impossible to realize with the hardware currently at our disposal, as a large number of multiplicators consumes too much space.

The SDM specific functional performance indicators relate to the stability of the converter, limit cycle and idle tone behavior, noise modulation, and transient performance.

- Stability

Higher order Sigma-Delta Modulators are conditionally stable. As a result, only signals below a certain maximum input level can be converted without causing the modulator to become Unstable.

- Limit Cycles and Idle Tones

Because of the non-linear behavior of a few-bit SDM, the output signal can sometimes contain correlated frequency components that are not present in the input signal and that are not part of the normal quantization noise floor. When limit cycles are present in the output signal of an SDM, typically no signal content except DC is present at the input, although in theory also a generic repetitive input signal, e.g. a sinusoid, could be present. In practice, limit cycles only show up when the input signal is removed and a small DC offset remains. Depending on the DC level, which determines the frequency content of the limit cycle, the limit cycle can contain in-band components and cause problems or only contain harmless high frequency components. Idle tones on the other hand typically occur when an input signal is present at the input of an SDM. Harmless high frequency idle tones are often present in the output spectrum of an SDM, but depending on the input signal the frequency of an idle tone can also be in-band and cause significant degradation of the output signal quality. Higher order modulators typically show less idle tones than low order modulators. By dithering a modulator mildly the power in idle tones can be reduced, but to fully avoid all possible idle tones a very significant amount of dither is required, penalizing the stable input range of the modulator severely. Therefore, a modulator that does not introduce idle tones or limit cycles is preferred

- Transient Performance

Because an SDM is an oversampled system that relies on noise shaping and feedback to realize amplitude resolution, it is not under all conditions able to encode the input signal with an equally high precision. For example, when a modulator is close to instability it can have difficulty to accurately follow transients in the input signal. When this happens, temporarily relatively large encoding errors are introduced until the modulator has recovered. Since the occurrence of this effect depends on the state of the system, it is difficult to detect or measure the impact using steady-state signals. By performing an analysis on dynamically changing signals,using a transient signal analysis method, it is possible to detect such encoding errors if they are not masked by other encoding imperfections.

5.Proposed Work

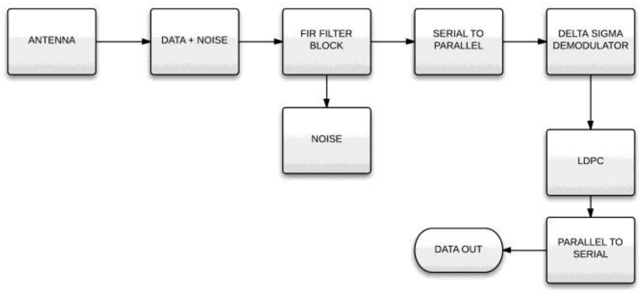

Figure 4: Receiver section.

The proposed work is the implementation of receiver section.In the rceiver section the reverse process of transmitter section is done.The output data generated from the transmitter section is given to the receiver antenna.The noise is added to the transmitting data through the channel.I t can be removed by FIR filter bank.Then the data is demodulated by QAM demodulator.After demodulation the inphase an quadrature signals will obtain.

5.1FIR Filter Bank In Receiver Section

Fig.4 represents the FIR filter bank in the receiver secton. Many digital signal processing (DSP) systems suffer from the problem that their complexity may become intolerably high when their bandwidths approach the whole Nyquist band. This corresponds to one or several don't-care bands approaching zero. For linear and time-invariant (LTI) frequency-selective finite-length impulse response (FIR). filters, the frequency-response masking (FRM) technique can then be used to reduce the complexity due to the use of one or several periodic (sparse) sub filters.

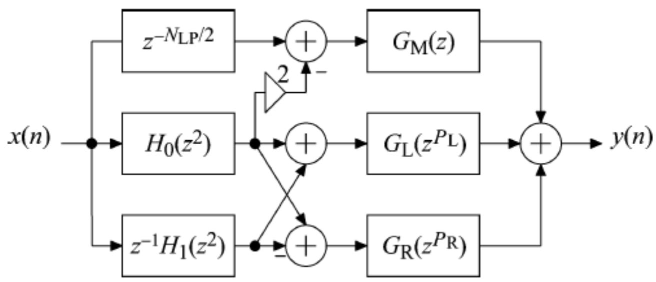

Figure 5: FIR filter

6.Result And Discussion

The single channel transmitter architecture was implemented in an VHDL and result are obtained as follows.

Fig.6 is the simulated output of single channel transmitter. It uses the single chaannel for the transmission of data.Data di is the inphase component and dq is the quadrature components which are given to the delta sigma modulator.At 3 ns interval the input data changes and corresponding transmitted output is produced.By varying the input datas,the output changes correspondingly.From the output waveform,the first input di is 10000011 and quadrature component is 11000111.The corresponding output is 11000111.After 3ns both the di and dq changesand also the output changes.Then it will repeat for each 3ns.

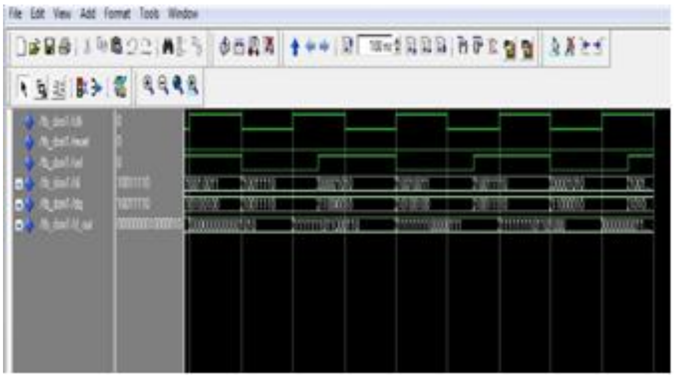

Figure 6: Single channel simulated output.

Fig.7 is the simulated output of multichannel delta sigma based transmitter.For the multichanneloperation it uses four channels.The inputs are di1,di2,di3 and di4 and its corresponding quadrature inputs are dq1,dq2,dq3 and dq4.So four pair of delta sigma modulators are used.

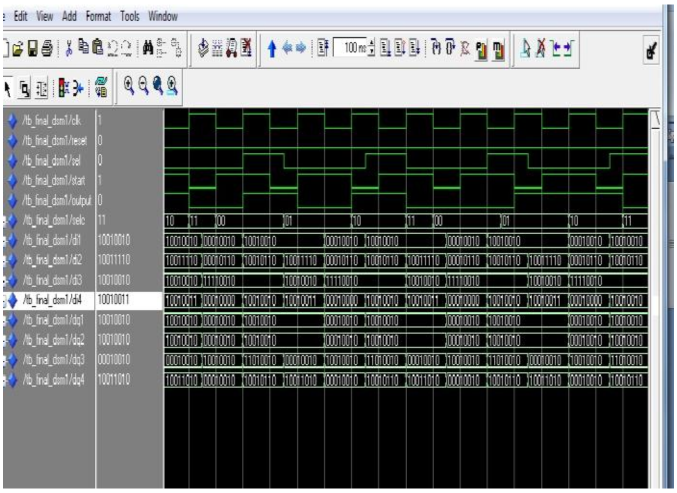

Figure 7:Simulated multichannel output.

7.Applications

- In the telecommunications industry, RF transmitters are designed to fit in a metal rack that can be installed in a cabinet.
- RF transmitters are used in radios and in electronic article surveillance systems (EAS) found in retail stores.
- Inventory management systems use RF transmitters as an alternative to barcodes.

8.Conclusion

In this paper, a new multichannel multimode transmitter and receiver architecture is presented and validated. The main component used in the transmitter section is DSM modulator. The output data obtained from the transmitter section is given to the receiver section. After the demodulation process the inphase and quadrature components can be retrive. Moreover, the use of a switching-mode PA for driving the digital RF output signal of the serializer has the potential for enabling wireless data transmission with higher power efficiency.The fast switch of the carriers' frequencies makes this transmitter interesting for improving jamming robustness and for cognitive radio based applications.

Author Profile

9.Acknowledgement

I would like to express my sincere gratitude heartfelt indebtedness to Mr. Issac S, Dr. Ibrahim Sadhar and Ms. Sabeena for their valuable guidance and encouragement in pursuing this work.

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