A Design of Non-coherent UWB Analog Front-End

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Abstract – *We propose a AFE(Analog Front-End) for noncoherent OOK(On-Off Keying) Ultra Wide Band system based on magnitude detection. The proposed AFE are designed using 0.18 μm CMOS technology and verified by SPICE and measurement. The AFE consist of parallelizer, A/D converter, clock generator and impulse generator. The time resolution of 1ns is obtained with 125MHz system clock and 8x parallelization. The synchronized eight outputs with 2-bit resolution are delivered to the baseband. The Impulse generator produces 1ns width pulse. The simulation and measurement results show the feasibility of the proposed UWB AFE for UWB communication system.*

Keywords: AFE(Analog Front-End), UWB(Ultra Wide Band), OOK(On-Off Keying), A/D Converter, Parallelizer, synchronizer

1 Introduction

Recently, interest on UWB(Ultra Wide Band) is rapidly growing along with wireless high-speed data communication with low power consumption.[1][2] For the realization of the system based on UWB, it is essential that power consumption as low as possible. To meet this low power requirement, OOK(On-Off Keying) modulation, non-coherent detection and single chip integration are necessary. We propose a CMOS AFE for UWB which plays an important role in connecting the RF block and baseband. And we show the feasibility of the proposed CMOS AFE with measurement results.

2 Analog Front-End Design

2.1 Non-coherent OOK UWB system

The proposed UWB architecture is shown in Figure 1. The AFE consist of parallelizer, A/D converter, synchronizer, clock generator and impulse generator.

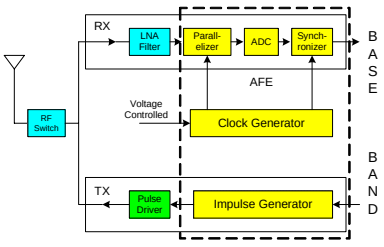


Figure 1. The block diagram of noncohernet UWB system

Signal demodulation in the proposed noncoherent OOK UWB system is simply performed by comparing the received pulse power with the detection threshold. Thus, the proposed UWB receiver is less sensitive to signal synchronization, and the receiver structure is very simple since reference pulse generator and correlator is not necessary.

2.2 Parallelizer

The data rate of UWB system is very high, so parallelization is needed interconnecting to a baseband block. The parallelization reduces the speed of system clock and overcomes the speed limitation of general baseband block. The block diagram is shown in Figure 2.

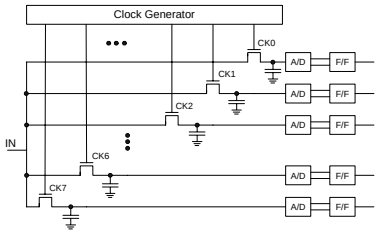


Figure 2. The parallelization of high-speed RF-signal

2.3 Clock Generator

Clock Generator should generates control clocks which have equal delay difference one another and the delay between adjacent clocks is controlled by the external voltage. The ring-oscillator architecture with frequency control is selected because the delay should be varied according to system clock. Total 8-stage are connected and differential signaling is used. The target oscillation frequency is 125MHz, so the delay of delay cell is about 0.5ns. But the delay between control clocks is 1ns, so the outputs of even number cells are used.

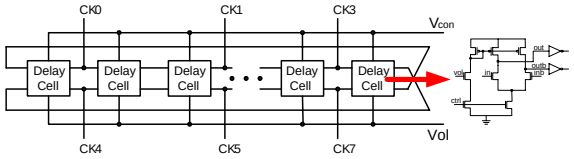


Figure 3. Clock Generator block diagram

2.4 Analog-to-Digital Converter

The RF stage delivers high speed analog signal, but most of baseband is processed in digital manner. So, we

This work was supported by IDEC, Dongbu Anam 0.18 μm

propose a simple A/D converter which is suitable to short pulse processing. 2-bit resolution flash-type A/D converter is designed. The block diagram is shown in Figure 4 and its operation is controlled by clock signal input. The reference voltage used in A/D converter are 0.45V, 0.9V and 1.35V. The key block, "COMP+LATCH", consist of differential input stage, amplification stage and latching circuit.

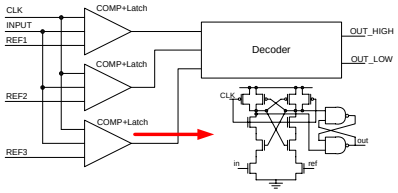


Figure 4. 2-bit flash-type A/D converter

2.5 Synchronizer

The edge triggered D-type flip-flop is used for synchronizing the parallelized signals. The outputs of A/D converters are not synchronized, because the S/H blocks use the different clocks for parallelization.

2.6 Impulse Generator

The UWB communication system based on impulse radio architecture requires very narrow pulses whose width is below nanosecond typically.[3] Simple and low power impulse generator is designed using CMOS technology and pulse generation is carried out using several high performance gates. The block diagram is shown in Figure 5.

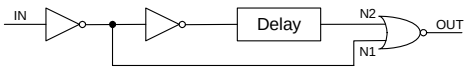


Figure 5. Impulse Generator

3 Measurement

3.1 Impulse Generator Measurement

The measurement of impulse generator is shown in figure 6. The system clock is used as the input of impulse generator and the pulse of about 1ns width is generated using circuit in Figure 5. The x-axis is 50nsec/div and the y-axis is 1V/div in Figure 6.

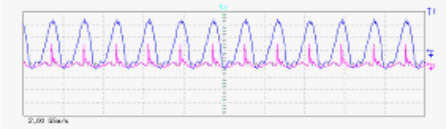


Figure 6. Impulse Generator Measurement

3.2 Clock Generator measurement

The measurement result of the clock generator is shown in Figure 7. The 1st and 2nd, 1st and 3rd clocks are displayed and delay time between clocks are about 1ns. The x-axis is 10nsec/div and the y-axis is 1V/div in Figure 7.

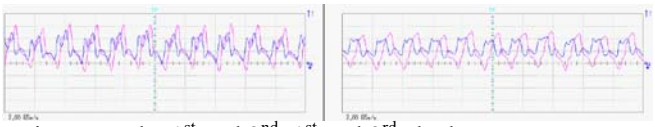
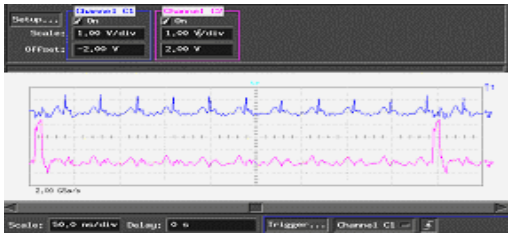


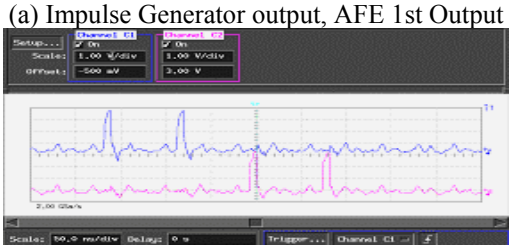
Figure 7. The 1st and 2nd, 1st and 3rd clock Measurement

3.3 AFE Measurement with Synchronizer

The parallelized output of A/D converters are not synchronized because clocks are delayed about 1ns one another, so an edge triggered D-type flip-flop is used for the synchronization. The synchronized output of flip-flops are shown in Figure 8. Three Output signals from eight parallelized outputs are plotted figure 8. The x-axis is 50nsec/div and the y-axis is 1V/div in the picture.



(a) Impulse Generator output, AFE 1st Output



(b) AFE 2nd, 3rd Output

Figure 8. Analog Front-End Measurement (a) Impulse Generator output, AFE 1st Output (b) AFE 2nd, 3rd Output

4 Conclusions

In this paper, we proposed and verified the AFE for noncoherent UWB system based on energy detection. The AFE for noncoherent UWB system is designed using 0.18 μm CMOS technology. Measurement results on Impulse Generator, clock generator and 2-bit A/D converter with Synchronizer show the feasibility of the proposed AFE for noncohrent UWB system.

References

[1] FCC, Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission, ET Docket 98-153, April 2002.

[2] http://www.ieee802.org/15/pub/TG3a.html

[3] I. J. Immeoreev and A. A. Sudakov, "Ultra-Wideband Communication System with High Data Rate," Ultrawideband and Ultrashort Impulse Signals (UWBUSIS'02), Oct. 2002.