Chip for autocorrelation spectrometer applications with integrated digitizer

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INTRODUCTION

A chip for autocorrelation spectrometer applications has been designed. The chip contains both a digitizer and a digital signal processor. The digitizer transforms an analog baseband signal to digital information and the digital signal processor calculates the autocorrelation function for the data that the digitizer provides. The autocorrelation spectrometers built today contains two different chips for these two circuit functions. The chip is being manufactured using a 0.18 μm SiGe BiCMOS process. This paper will first describe an autocorrelator system, and then describe the two main functions of the chip. At last, the pros and cons of higher integration is described.

THE AUTOCORRELATION SPECTROMETER SYSTEM

The autocorrelation function of a discrete sequence, *x(n)*, of length N is defined as:

$$R_{xx}(l) = \sum_{l=0}^{N-1} x(n)x(n-l), l, n \in Z$$

By applying the discrete Fourier transform to the autocorrelation function the power spectrum is obtained. The resolution of the spectrum is improved by increasing the length, l, of the function. The autocorrelation function can be easily realized using a digital integrated circuit. The input to the spectrometer is some analog frequency band that is being observed. This band is down converted and split into subbands . The subbands are individually down converted to baseband. The baseband information is quantized by the digitizer and then fed to the autocorrelation circuit.

THE DIGITIZER

The baseband signals are analog and need to be converted to digital data in order to be manageable by the digital autocorrelator. For this, a digitizer is used. Time multiplexing may be used since the quantization is possible to achieve at higher frequencies than the following digital signal processing. The digitizer was designed using the bipolar transistors in the process. The reason for this is that the bipolar transistors gives the possibility to design high speed high precision comparators. In order to reduce the influence of noise on the data and reference ports, a differential output was chosen.

THE AUTOCORRELATOR

The serial output data from the digitizer is fed to the autocorrelator. This data is then split in two identical parts and fed to a multiplier that calculates the autocorrelation function for zero delay, l=0. One of the serial data paths is then delayed one clock cycle and multiplied with the initial data to produce the function for l=1. This procedure is then repeated until the desired resolution is obtained. Synchronization blocks have been introduced every sixteen delay block in order to synchronize the data and the clock.

BENEFITS OF BiCMOS AND CONCLUSIONS

The first and most obvious benefit of higher integration using SiGe BiCMOS is the reduction of the complex I/O between the two circuits. This interface is rather complex to manufacture when building the spectrometer. The SiGe HBTs have higher maximum frequency of operation than the bipolar transistors that have been used in the past. Also the CMOS part is faster than before, this mans that the bandwidth possible to analyze has been increased. One step in technology also means smaller devices and less power consumption.