Abstract

Joint synchronization and calibration of multi-channel transform-domain charge sampling receivers

(May 2009)

Pradeep Kotte Prakasam

Chair of Advisory Committee: Sebastian Hoyos

Transform-domain (TD) sampling is seen as a potential candidate for wideband and ultra-wideband high-performance receivers and is investigated in detail in this research. TD receivers expand the signal over a set of basis functions and operate on the digitized basis coefficients. This parallel digital signal processing relaxes the sampling requirements opening the doors to higher dynamic range and wider bandwidth in receivers. This research is focused on the implementation of a high performance multi-channel wideband receiver that is based on Frequency-domain (FD) sampling, a special case of TD sampling. To achieve high dynamic ranges in these receivers, it is critical that the digital post processing block matches the analog RF front end accurately. This accurate matching has to be ensured across several process variations, mismatches and offsets that can be present in integrated circuit implementations. A unified model has been defined for the FD multi-channel receiver that contains all these imperfections and a joint synchronization and calibration technique, based on the Least-mean-squared (LMS) algorithm, is presented to track them. A maximum likelihood (ML) algorithm is used to estimate the frequency offset in carriers which is corrected prior to LMS calibration. Simulation results are provided to support these concepts. The sampling circuits in FD receivers are based on charge-sampling and a multi-channel charge-sampling receiver creates an inherent sinc filter-bank that has several advantages compared to the conventional analog filter banks used in other multi-channel receivers. It is shown that the sinc filter banks, besides reduced analog complexity, have very low computational complexity in data estimation which greatly reduces the digital power consumption of these filters. The digital complexity of data estimation in the sinc fiter bank is shown to be less than 1=10th of the complexity in analog filter banks.