Extended Approaches for M – Sequence based UWB Sensors

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Ultra wideband (UWB) sensors become more and more interesting for a great deal of applications in various areas, such as surface penetrating radar, surveillance and emergency equipment, medical instrumentation, non-destructive testing in civil engineering, industrial sensors, microwave imaging, sounding of mobile communication channels etc. This results in a diversity of requirements concerning the measurement system – touching both its electronics and signal processing.

In order to meet primary requirements of a specific application as good as possible, it is of advantage to have the choice between different measurement approaches. The classical and as of now mostly used UWB-method is based on short pulse signals. Sine wave techniques, on the other hand, can also cover a large bandwidth by sweeping the frequency. Strictly speaking, they do not count as UWB-methods, since the instantaneous signal spectrum is a narrow band one.

As an alternative to these approaches, we developed an ultra-wideband pseudo noise method. Its big advantage is that the signal energy is homogenously distributed over time avoiding high signal peaks. This promotes monolithic circuit integration in a low cost RF-technology as SiGe:C BiCMOS. A pseudo noise code is a CW-signal that needs to be pulse compressed in order to gain time resolution. Using numerical (digital) methods, this can be done in a robust and easy-to-implement way. The usual pseudo noise code is an M-Sequence due to its perfect auto-correlation properties. But the principle is not restricted to that code.

The basic concept of the UWB M-Sequence approach was presented in 1999. Meanwhile, some extended concepts have been introduced and are under investigation. The article will describe these extended concepts and refer to their advantages and disadvantages. The bandwidth of the basic UWB M-Sequence device covers the band from DC to $f_c/2$ where f_c represents the clock rate that pushes the code generator. The current code generator is working up to $f_c = 15$ GHz.

The extensions, which will mainly be considered in this paper, refers to methods,

- which increase the bandwidth from DC to $3f_c/2$, while keeping the semi-conductor technology,
- which avoid the need of any analogue filter for suppression of aliasing effects, or
- which permit wideband operation at an arbitrary centre frequency.

Measurement examples will be shown to demonstrate the operation in the baseband (i.e. DC to 5 GHz or DC to 12 GHz), the UWB-band (3… 10 GHz), or even in other frequency bands (e.g. 60 GHz).