Ultra Wideband Amplifier
Functional Description and Block Diagram

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History of Ultra Wideband Communications

Ultra Wideband (UWB) communication is used for large bandwidth, low power, data transmission over a short distance. It is fundamentally different from other techniques because it uses extremely narrow Radio Frequency (RF) pulses to communicate between transmitters and receivers.

In 1901, Guglielmo Marconi used UWB to transmit Morse code sequences using spark-gap radio transmitters. From the 1960's to the 1980's UWB technology was restricted to military and the Department of Defense for use in highly secure communication applications. Because of recent advancement in semi-conductors and micro-processing techniques UWB can be put to commercial use.

The Federation Communications Commission (FCC) had previously outlawed UWB until developers pressured the FCC to approve it. In 1998, developers got their wish for UWB to be legalized under the First Report and Order for commercial use of UWB technology. The usable UWB frequency range is from 3.1 to 10.6 GHz. The FCC also limits signal transmission power to spectral density levels of 41.3 dBm/MHz.

Advantages and disadvantages of UWB

Since UWB is limited to low power spectral densities, UWB communication systems can co-exist with other narrow band systems without interfering with one another. Another advantage is that it has large channel capacity with low signal to noise ratio, or large data rate transfer speeds. Speeds in the GHz range can be expected. With the low transmission power needed to transfer data, UWB is not easily detected or intercepted.

There are also some challenges to UWB communications. The transmission characteristics of UWB pulses are much more complicated than that of the narrowband systems because of distortion concerns. The UWB has low powered pulses because of the FCC regulations, and this causes the pulses to be able to distort significantly by the transmission link. Time synchronization between the receiver and the transmitter is a problem in UWB because of the speed of transmission (nanoseconds).

The challenges of UWB will be encountered in the designing of the amplifier. The UWB pulses are very easy to distort, so our specifications must take this into consideration. The signal has to be amplified without distorting the received signal pulses and must not interfere with other frequencies in the area as well as be able to function with outside interferences.

Applications

UWB communication can be used in military as well as commercial applications. Everything from radars, tactical radios, and precision geological locating systems are some uses for government and military. Consumer applications in the future could consist of having every

electronic gadget in a home wirelessly connected. Then one could transmit data from the DVD player to the TV to play movies without using any wires to connect the two devices.

Functional Description

The purpose of this project is to research, design, fabricate, and test a radio frequency (RF) amplifier to be used in the Ultra Wide Band (UWB) system. This amplifier to be designed will be used in the UWB receiver. A low noise amplifier (LNA) will be designed. The amplifier topology will be that of a distributed amplifier. Ideally, we would like to use packaged CMOS transistor technology in the design.

Goals

- Research an amplifier design
- Fabricate and implement the design of the amplifier
- Creating and meeting specification for the UWB amplifier
- Test and implement the amplifier

System Block Diagram

A basic UWB system will have a signal pulse generator that generates a Gaussian pulse. The encoded signal is transmitted using the Gaussian pulses. The pulses are amplified and transmitted via antenna to the receiver. Once the receiving antenna receives the signal the low noise amplifier will amplify the signal before it continues on into the receiver. Figure 1 shows the system block diagram. The LNA is the subsystem that we will design.

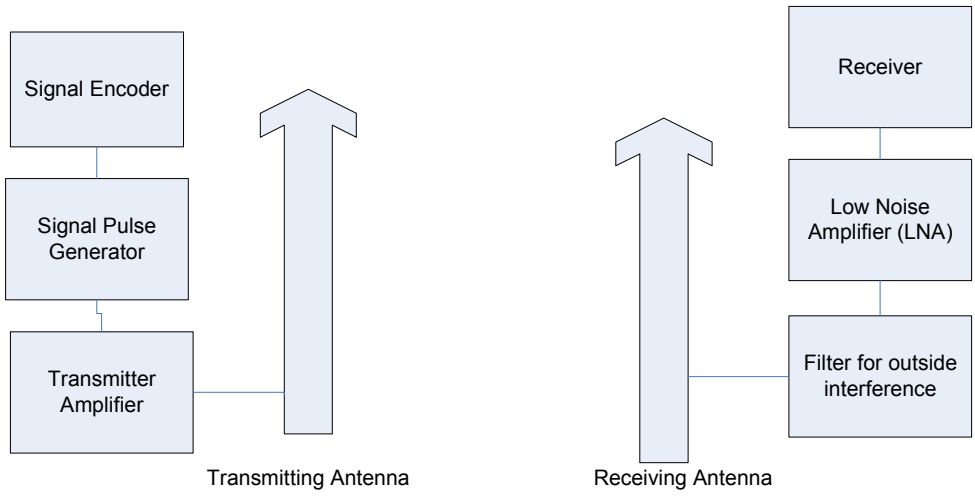

Figure 1: System Block Diagram of UWB System

Figure 2 shows an overview of a UWB receiver system. The LNA is shown in the overview right next to the pre-select filter. In this project our focus is the LNA. The antenna receives the signal from the outside source. The LNA will amplify this signal.

The input to LNA will be a signal received from a UWB transmitter. The output of the amplifier will be an amplified signal with low noise added.

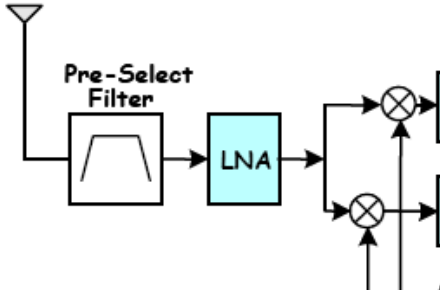

Figure 2: Functional Block Diagram of a UWB Receiver

Conclusion

Currently the project is in the research and design phase. Research is being conducted to determine the optimal specifications of the desired amplifier. Our frequency range is that of the UWB spectrum. More research on the noise figures, power levels, power dissipation, gain, and amplifier layouts are currently being done.

In the design area, the use of hybrid CMOS packaged transistor is being researched. Ideally, these would be used to implement the amplifier design due to the fact that Bradley University has never done any work with the CMOS technology; packaged transistors will be used due to time limitations.

References:

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