UWB Antenna

Functional Requirements List and Performance Specifications

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Introduction

An antenna is a transducer between a guided wave propagating in a transmission line, and an electromagnetic wave propagating in an unbounded medium, like air. All wireless systems have a transmitting antenna and a receiving antenna. The transmitting antenna is the antenna that obtains the signal from the source. The receiving antenna is the antenna that outputs the desired signal to a receiver. Antennas are used for many applications; one of the more recognizable applications is radio. The receiving antenna on a car collects the signal from the radio station and outputs the signal into the receiver. Music can now be heard in the car! The application being used in this project will be ultra wideband (UWB) wireless systems.

UWB is defined as a system having a bandwidth greater than 500 megahertz (MHz). UWB ranges from 3.1 GHz to 10.6 GHz. UWB signals are pulse-based waveforms compressed in time, instead of sinusoidal waveforms compressed in frequency. The advantages of using UWB frequencies are higher bandwidth, reduced fading from multi-path, and low power requirements. Figure 1-1 is an example of a UWB signal. The figure shows the difference between a narrowband signal and a UWB signal. The bandwidth of the UWB signal is much more larger than the narrowband, which means UWB signals can operate over wider frequencies.

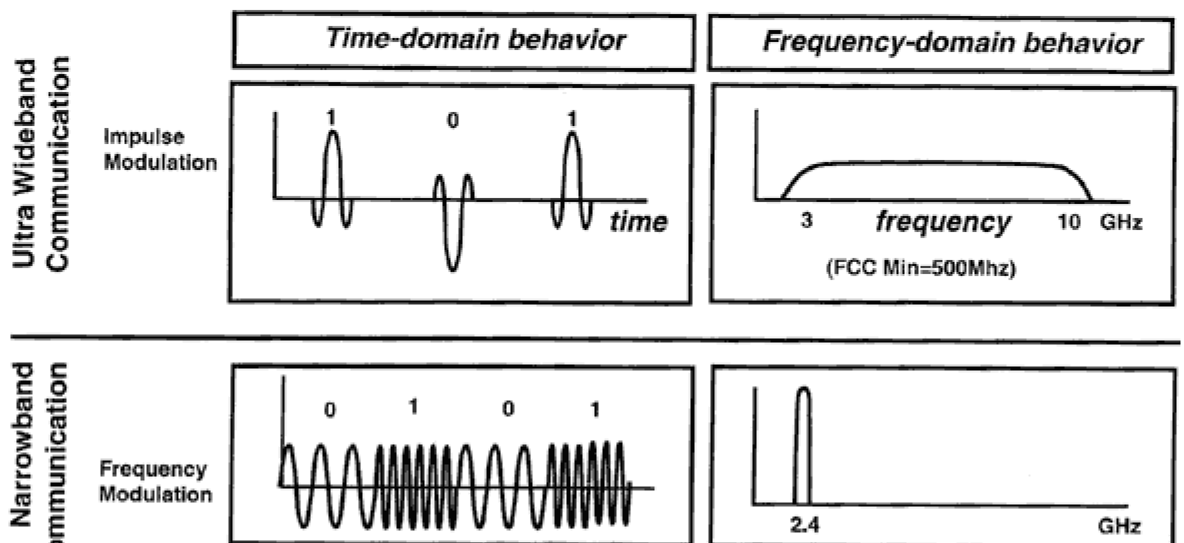

Figure 1-1
Difference between UWB and Narrowband

The project guidelines are to design and construct an antenna that transmits or receives UWB signals. The UWB signal will be outputted to a spectrum analyzer. A small, but important goal of the project is to understand the basics about antennas. The student hasn't had any classes about antennas, so some research and study will have to be done. The main goal of the project is to build a working antenna that is used for UWB applications.

Overall System Block Diagram

The input UWB signal of the antenna will go to the antenna. The antenna can be transmitting or receiving. The signal travels through air and ends up at the receiver, or the spectrum analyzer. (See Figure 3-1.)

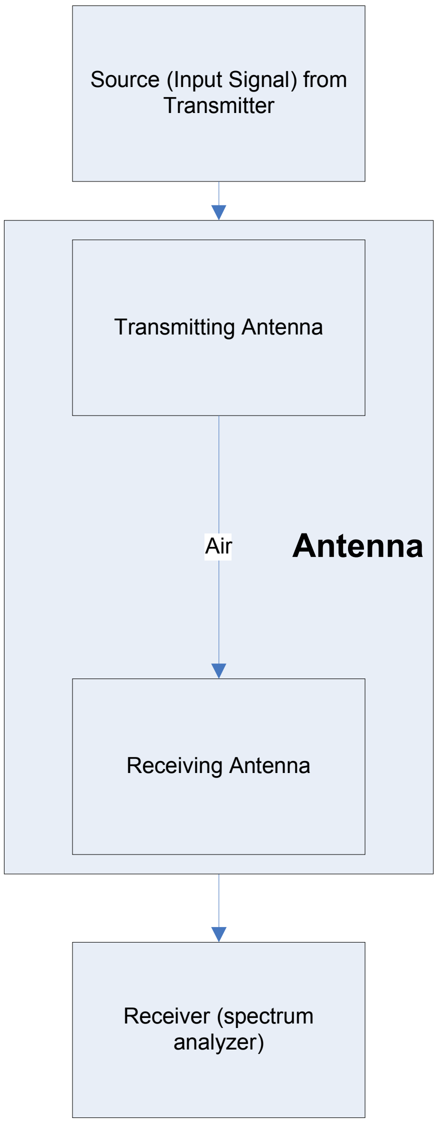

Figure 3-1
Overall System Block Diagram

Source

The source is what generates the signal. The signal will be a UWB signal, which means the signal's frequency will be 3.1 GHz to 10.6 GHz. The source of the UWB antenna has not been chosen yet.

Antenna

The antenna is the "meat" of the project, and the antenna must be able to transmit or receive UWB frequencies. Whether the antenna is transmitting or receiving has not been decided yet, but a transmission line will have to be made so there is impedance matching for the antenna.

Receiver

After the signal leaves the antenna, the signal will be delivered to the receiver. The receiver, more than likely a spectrum analyzer, will output the signal. With the spectrum analyzer, the student and advisor will be able to observe what power loses were obtained in the systems. The power loses shall be small enough so that the input signal shall be close to the same as the received signal.

Requirements and Performance Specifications

The antenna's radiation pattern shall be Omni-directional. Omni-directional means that the signal waves passing through antenna shall be able to travel in all directions. The antenna shall be small in size and be printed on a high frequency circuit board. Along with the small size of the antenna, the antenna shall be low in cost. The VSWR, Voltage Standing Wave Ratio, shall be less than 2. If the VSWR would be equal to 1, then the antenna would be perfectly matched. The gain in dB of the antenna shall be less than 5 and relatively constant over UWB frequencies. The impedance of the antenna shall be matched and be a value that is easy to create on a high frequency circuit board. The UWB signal cannot be distorted after traveling through the antenna.

There are many types of antennas to use to make the UWB antenna. A small list of antennas is given in the Additional Information section of this document. The exact limit on the size of the antenna is not given because the definition of small is interpreted differently for person to person. An example is a monopole antenna found in the UWB Research Papers on the CD received from Dr. Shastry. The antenna's dimensions were 50 millimeters by 50 millimeters by 0.8 millimeters. Dr. Shastry said this would be a good size for the UWB antenna for this project. As long as the antenna fits easily on a desktop, the size of the antenna size will be reasonable.

Additional Information

The antenna will be created on a high frequency circuit board; this is just being taught in EE 551 RF Circuits. A better understanding of the high frequency circuit board will be obtained in about two to three weeks. There are many types of antennas. Monopole and dipole, spiral, and bi-conical are some examples, but the exact antenna that will be used in this project has not been decided yet by the student and advisor. More examining needs to be done so the student can have a better understanding of all types of antennas. The basics of antennas also still need to be explored through the EE 381 textbook, the UWB research papers, and EE 550 lecture tapes. Basically, more investigating needs to be done before any design and construction can begin on the UWB antenna.

References

Dr. Shastry, Bradley University, Professor and Advisor, 9 November 2007.

UWB Research Papers, CD from Dr. Shastry, Received: 2 October 2007

<u>Fundamentals of Applied Electromagnetics</u>, EE 381 Text Book, Fawwaz T. Ulaby