The basic objectives of this laboratory experiment were to design and build a radio telecommunications link utilizing Manchester encoding and binary frequency shift keying, a voltage controlled oscillator, and a patch antenna.

Manchester encoding gains its origins from the year of 1949 at the University of Manchester as a programming language for the Mark 1 computer. This computer was one of the first computers of its kind, which has the ability to store programs via a magnetic rotation disk. A fundamental problem of these disks are over saturation, or over exposure to a magnetic field which can cause inconsistencies between the desired bit value and the actual stored bit value. Manchester encoding relies on the rising or falling edge of the incoming clock signal in order to interpret a logical 1 or 0, which means there is less overall exposure time for the disk and the magnetic field. This is important because it allowed for more consistent data storage.

My primary focus in this project was the encoding of the data in Manchester format. Due to physical constraints of the Arduino Uno’s pin values for voltage levels, I ended up performing a DC offset type of Manchester where I use 0 Volts and 5 Volts as my logical ones and zeros. I then send these pins to the voltage controlled oscillator, which uses a transistor based switching circuit in order to up the voltage levels to the desired frequencies. In the case of this project, the transmitted frequencies were 2.48 GHz for a rising edge, and a 2.355 GHz signal for the falling edge. This is important because it represents the binary frequency shift keying aspect of Manchester encoding.

A major problem I faced is synchronization. Due to many factors such as delay in the receiver team’s reading operations, and Jitter, there may be skipped bits in data transfer. Jitter is defined as essentially missing data due to clock skew. This skew can happen from many factors, however it is very difficult to predict. In order to help counter these problems, we created a secondary output from the Arduino in order to act as an On/Off switch. This pin turns on and off a secondary transistor based switching system which provides power to the amplifier. This is important because the receiving team does not need to constantly be seeing incoming frequencies. They just wait for a frequency to appear and jump into detecting the edge direction, allowing for quicker synchronization and no need for a sacrificial byte or bit.

The patch antenna required a few tries by the antenna group. I spent numerous hours trying to tune and design it with them. The real success came from using a single stub tuning method. The patch was tuned with a single stub, and then re-tuned again with another stub on the other side of the feedline. This allowed for a very exceptional characteristic impedance of 49.56 + j3.68 Ω. This was only a mere 0.88% error from the desired 50Ω impedance of the feedline. The SWR was 1.05, which was only 5% off of the desired SWR of 1. These values are important that they are accurate because they allow for proper resonation at the design frequency as well as preventing harmful reflections from burning out the amplifier.

The basic objectives of this laboratory experiment were to design and build a radio telecommunications link utilizing Manchester encoding and binary frequency shift keying, a voltage controlled oscillator, and a patch antenna. All of the objectives were accomplished, and exceptional results were achieved with a signal propagating out of the laboratory room to the spectral analyzer. The final resulting setup can be seen in Fig. 1 attached in the relevant pictures section of this report.