Crystal Radio Engineering
Introduction

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Introduction

The purpose of this book is to illustrate applied engineering concepts and the associated thought process to electrical engineering students by using a project that is historical as well as fun. The goal is to learn engineering methods and then apply those to design and build a working crystal radio.

A crystal radio receives amplitude modulated signals generally in the AM broadcast band and produces an audio signal to earphones or even a speaker using only the energy of the received signal – no external power source is required. These radios have sometimes been called free power radios. Crystal sets (another name they go by) were used in the early days of radio prior to the development of vacuum tube amplifiers. A crystal radio consists of the following components:

- A wire antenna, typically 8 to 40 meters in length at a typical height of 3 to 8 meters, and corresponding earth ground to receive radio frequency energy
- An antenna tuning or matching system to couple power from the antenna to the first resonant circuit that is tuned to the desired station
- A resonant circuit (sometimes more than one) to select the frequency of the desired broadcast station
- A crystal detector to demodulate the AM signal thus producing an audio signal from the modulation
- An earphone or speaker to convert the audio signal to sound

The author has built a number of crystal radios over the years and it was a childhood quest to learn how to build the best crystal radio possible. In fact, an interest in crystal radios and radios in general led the author to become an electrical engineer. One of the radios built by the author could power a speaker such that the station could be readily heard on the opposite side of a quiet room – and it could be tuned to different stations with minimal interference. Although it was based on some good concepts, that event was blind luck in the author's youth but it did establish a benchmark for later life. Over the years the author has spent many hours of engineering trying to determine and explain the conditions required to replicate that radio. This book is the result. If an experiment can be replicated then it is science – and the author strongly believes in science. Otherwise it is magic and of no use. This book explains how you can use science and engineering to replicate that radio.

A major error made by students and even practicing engineers is to skimp the proper research and design process and jump to building hardware as soon as possible – this process is known as hacking – with luck it works – but it is mostly a waste of time. Before you can do design engineering you must have data and mathematical models of what you are trying to do. Sometimes data is readily available. Other times such as when you are doing something that has never been done before, only minimal if any data exists. Mathematical models may have errors or be incomplete based on knowledge you do not yet know. Thus, it is not uncommon for an experimental system to be constructed on a small scale in order to obtain data and refine and prove the mathematical models prior to expending a lot of time and money on the real system. The key to successful engineering is proper research done *prior* to the design phase. A crystal radio is an excellent example to demonstrate this because if any step is not understood or engineered well then the radio will not work well. The following chapters will illustrate the process from beginning to end.

Figure 1 shows a simple crystal radio that will be discussed in great detail in this book. The circuit illustrates each of the bullet points above.

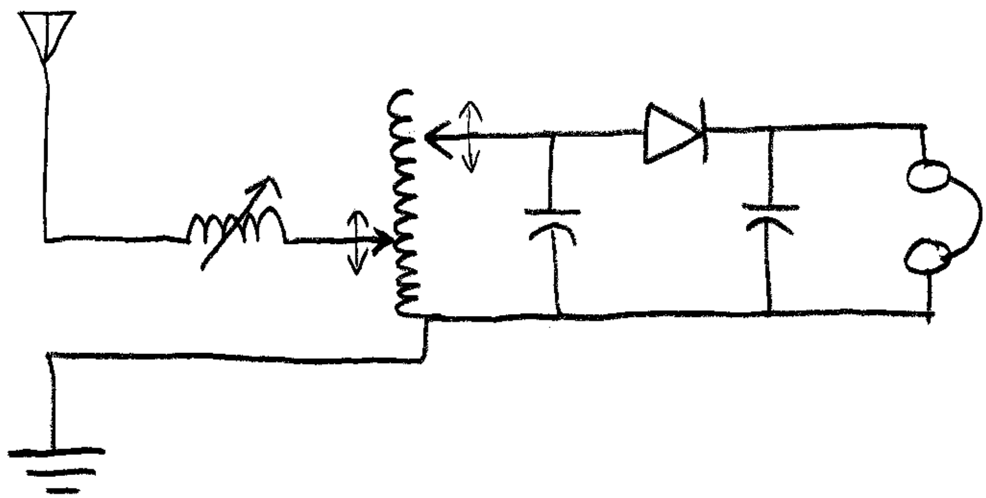

Figure 1: Simple Crystal Radio