Geitanksha Tandon
(geitanksha@gmail.com)

Superheterodyne AM Radio Receiver

**Content taken from ECE 210: Analog Signal Processing*

Introduction:

The most popular AM communications receiver is the superheterodyne receiver, which was developed for greater sensitivity and selectivity. A block diagram for the superheterodyne receiver is shown in Figure 1. The antenna, RF amplifier, and frequency mixer all rely on electrical components not covered in the textbook, but their effects on the incoming signal should be familiar.

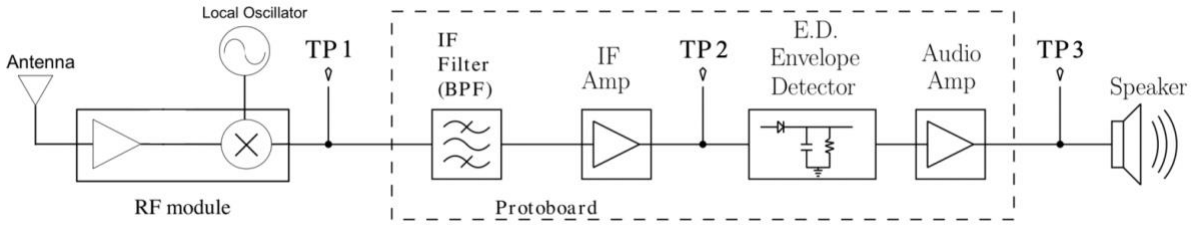

Figure 1: Full AM Radio Receiver Circuit

Parts of the AM Radio Receiver:

Over different labs, we managed to construct singular components of the AM Radio Receiver.

1. Envelope Detector (Lab 1)

An AM radio signal consists of a high-frequency sinusoid whose amplitude is modulated, or scaled, by a message signal. The message signal is the speech or music recorded at the radio station, and the objective of the AM radio receiver is to recover this message signal to present through loudspeakers to the listener. Figure 6 illustrates an AM signal with a co-sinusoidal amplitude modulation. The horizontal axis represents time, and the vertical axis is signal voltage. You can see the amplitude of the high-frequency sinusoid changes over time. In this case, the message signal is a low-frequency sinusoid. You can imagine the message signal as a low-frequency sinusoid connecting the peaks of the high-frequency sinusoid. Because the message signal connects the peaks of the high-frequency sinusoid, it is also called the AM signal's envelope, and a circuit that detects this envelope, producing the message signal, is called an envelope detector.

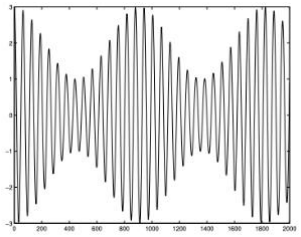

Figure 2: Illustration of AM Radio Signal.

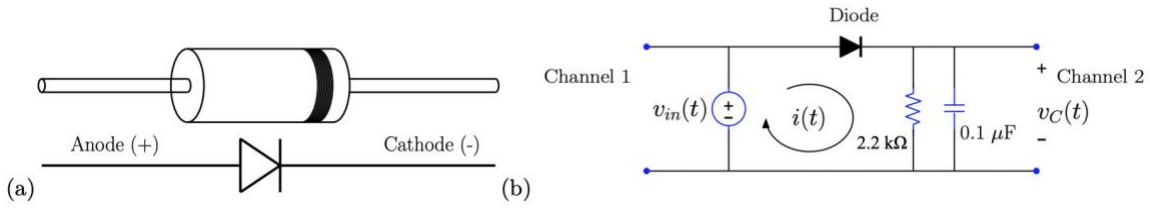

Figure 3: (a) Circuit symbol and physical diagram for a diode, and (b) an "envelope detector" circuit using a diode. For the Envelope detector we will use a Germanium(Ge) diode to take advantage of the low forward voltage drop (approximately 0.2 V).

Geitanksha Tandon
(geitanksha@gmail.com)

Superheterodyne AM Radio Receiver

**Content taken from ECE 210: Analog Signal Processing*

2. System Amplifier

We used 2 amplifiers in our system. The voltage of input signal must be sufficiently high to turn the diode on and off — hence the first amplifier. The second amplifier, which follows the envelope detector, increases the voltage of the recovered message signal in order to drive a loudspeaker. It also provides a buffer between the envelope detector and the loudspeaker, preventing the loudspeaker from changing the time constant of the tuned envelope detector.

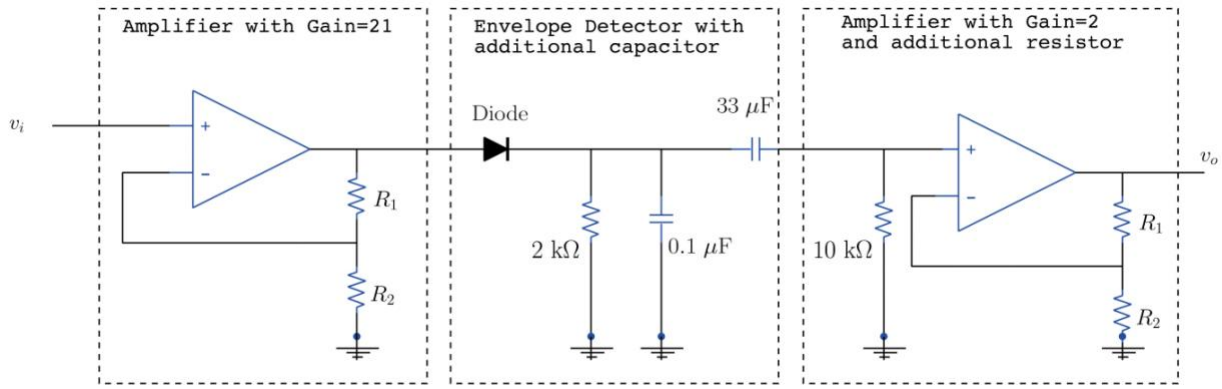

Figure 4: Three-stage circuit for radio.

3. Band-Pass Filter:

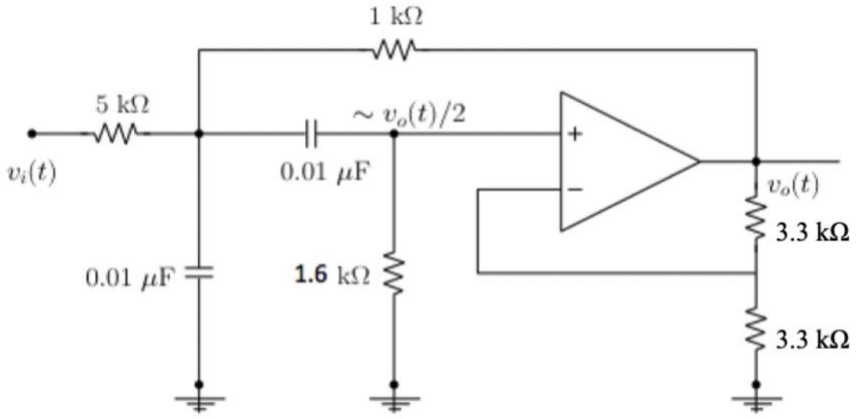

Figure 5: Preselect Filter: Band-Pass

This filter helps us solve the issue with the Image Station – when a message signal is moved to the carrier frequency, a different frequency (called image station frequency) may overlap and then cause unwanted noise. Hence, we use a preselect Band-Pass filter that is non-precise and wide that removes these unwanted frequencies.

Geitanksha Tandon
(geitanksha@gmail.com)

Superheterodyne AM Radio Receiver

**Content taken from ECE 210: Analog Signal Processing*

Problems and Challenges:

The major problems that I faced whilst constructing the entire circuit was that we did this circuit in disconnected components, working on it bimonthly. Hence, keeping track of which part of the circuit connected to the next section was confusing, as well as determining which section of the circuit was faulty whilst debugging errors, with the help of Scopy (multi-functional software toolset with strong capabilities for signal analysis)

References

[1] ECE 210: https://courses.grainger.illinois.edu/ece210/sp2022/

[2] Scopy Website: https://wiki.analog.com/university/tools/m2k/scopy

---