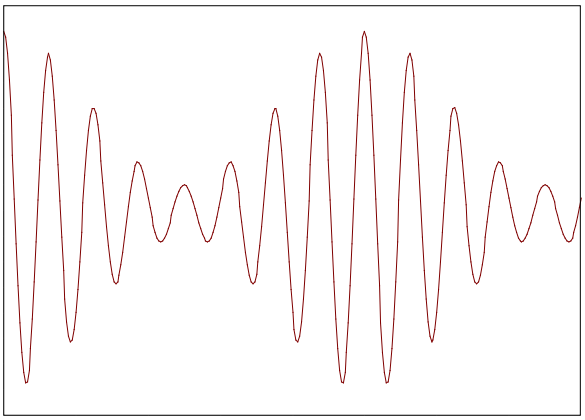
EE334
AM Demodulation

In the previous set of notes we learned what it means to create an AM signal. Now we'll learn how an AM broadcast is turned back into the baseband/intelligence signal. Basically, you'll learn the components and stages in an AM radio receiver. You'll also draw many of the figures used in this worksheet.

Recall that the intelligence signal rides on the AM wave. That is, if we connect the peaks of an AM signal, the curve that results is the intelligence signal (the voice, music, etc.).

1. Trace the peaks of the AM signal below to recover the intelligence signal being broadcast.



An AM receiver does the same thing you just did – traces the peaks of the AM wave to recover (reveal) the message signal. Let's build a receiver bit by bit.

The first thing the receiver needs is an antenna. The antenna is sensitive to the electromagnetic radiation (photons) that are the AM signal. As the photons strike the antenna, they create a very, very small voltage in the antenna. Because the received signal is so low in voltage, we'll need to amplify it before we can recover the message.

2. Start sketching our AM receiver by drawing an antenna and an amplifier in Figure 1. Make sure to include the signal as it might appear after each component (stage) of the receiver.

Figure 1. An AM receiver.

The next step is to remove either the positive or negative halves of the AM signal.

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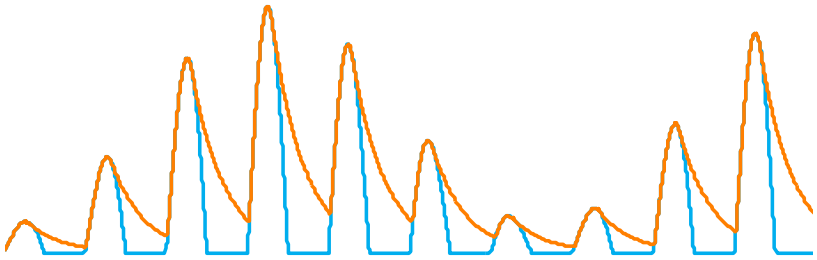
3. This can be done by adding a half-wave rectifier to the receiver in Figure 1. Remember to sketch the waveform at the output of the half-wave rectifier. Assume that the diode is ideal.

We've isolated one copy of the message. The message is still riding on the wave, however. Now we need to recover it, by tracing the peaks of the half-wave.

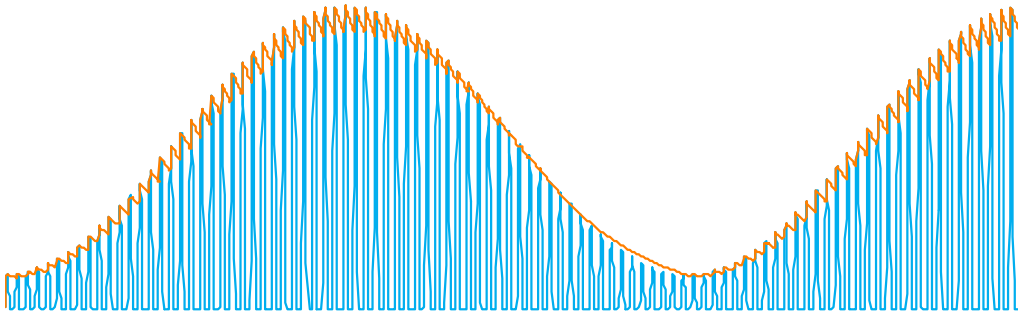
4. As your instructor will demonstrate, this can be done by adding a capacitor to the receiver of Figure 1.

The capacitor works with the resistor that's already in the circuit to trace the peaks of the AM half wave in the following manner:

- When the voltage of the half-wave is rising, the capacitor quickly charges, matching the voltage of the half-wave.
- When the voltage of the half-wave is falling, the capacitor slowly discharges through the resistor.
- Since the capacitor discharges (loses voltage) at a slower rate than the half-wave voltage, the effect is that the capacitor remembers the voltage peak of the half-wave that just occurred.
- A close-up and far-off view of the voltage across the capacitor can be seen in Figure 2.



(a)



(b)

Figure 2. The voltage behavior of the capacitor close-up (a) and a more zoomed out realistic example with a very fast carrier (b).

5. Shown below in Figure 5 is an example of a trace gone bad. Something's wrong with the capacitor. What is it?

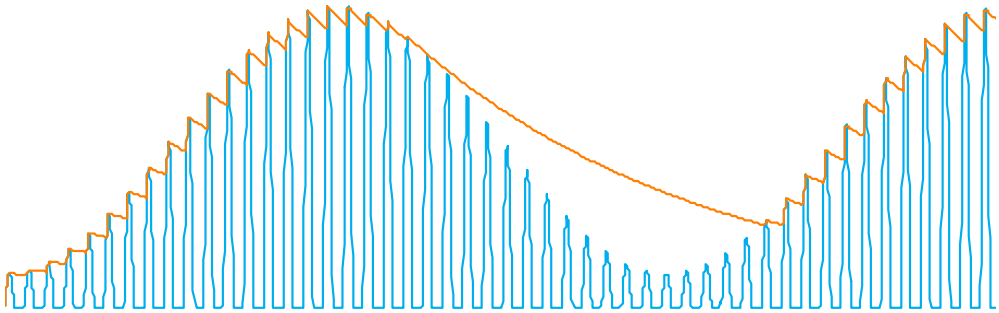


Figure 5. An AM envelope trace gone bad.

6. What would the recovered intelligence signal look like if the capacitor was too small?

7. Note that the recovered signal is very jagged. What can be done to make it less jagged?

8. Sketch the voltage waveform appearing across the capacitor in Figure 1.

Ok, we're almost done. The waveform appearing across the capacitor (see problem #4) has the shape of the intelligence signal. The only problem is that the waveform is not centered on zero volts – the waveform is shifted up due to a **DC bias** in the signal at that point.

9. This can be remedied by adding a second capacitor, called a **blocking capacitor**, to the circuit in Figure 1 as your instructor will demonstrate.

10. Sketch the waveform at the output of the blocking capacitor of Figure 1.

11. Explain how or why the blocking capacitor removes the DC bias from the intelligence signal.

The signal coming out of the blocking capacitor is very weak. We want it to be weak, because we can use cheap and simple components on weak, low-power signals. In order to listen to the recovered signal, we need to amplify it so that it has enough power to drive a speaker. We also need to add a speaker so that we can hear!

12. Complete your AM receiver in Figure 1. Make sure you have labeled each component. Include sketches between each component showing what the signal looks like at that point. Don't forget the amplifier and speaker mentioned at the bottom of the previous page.