Digital Communications Lab

Lab #6

Experiment

1. The signal generators in the lab can produce sine waves, at any amplitude you select (within the range of the equipment). There are two ways to control the amplitude. One is with the front panel controls, where you manually enter the amplitude. The other way to control the amplitude is with the AM Modulation input. This input accepts a voltage, and changes the amplitude of the sine wave at the output based on this voltage. Connect a DC power supply to the AM Modulation input of a signal generator. Set the front panel amplitude of the sine wave to 1 volt. Vary the DC voltage at the AM Modulation input, and determine the minimum amplitude you can generate at the output, and the maximum amplitude.

2. What is the gain of the AM Modulation input? In other words, when you change the AM Modulation input by 1 volt, how many volts does the amplitude of the output waveform change by?

3. Can the AM Modulation input cause the output amplitude to go negative? Would you know it if it happened, or is this something impossible to measure in a laboratory setting?

4. Set the signal generator to produce a 1 MHz sine wave. Replace the DC power supply on the AM Modulation input with a second signal generator, set to produce a 1 kHz sine wave. Adjust the amplitude of the AM Modulation input so the 1 MHz sine wave varies from 0.5 to 1.5 volts. Confirm this is correct by looking at the 1 MHz signal and the 1 kHz signal on the oscilloscope at the same time.

5. Vary the amplitude of the 1 kHz sine wave, and describe what effect this has on the 1 MHz modulated signal, as you watch it on the oscilloscope.

6. Can you now determine if the AM modulation input can cause the amplitude of the output signal to go negative? If so, describe how.

7. Look at the 1 kHz sine wave on a spectrum analyzer.

8. Look at the 1 MHz sine wave on the spectrum analyzer both when there is nothing on the AM Modulation input, and when there is a 1 kHz sine wave at the AM Modulation input. What happens to the spectrum of the modulated 1 MHz signal as you vary the amplitude of the 1 kHz signal? How does the amplitude of the 1 kHz signal impact the bandwidth of the modulated 1 MHz signal?

9. Switch out the 1 kHz sine wave, for either a 1 kHz square wave or a PN sequence that is clockec at 1 kHz. Look at the modulated 1 MHz signal on both the oscilloscope and spectrum analyzer. Describe how they look different from when a 1 kHz sine wave was used. What is the bandwidth of the 1 MHz modulated signal?

10. The bandwidth of the 1 MHz modulated signal should be very large in the previous step. Try limiting it by filtering the square wave, or PN sequence, before it enters the AM Modulation input. Use a low pass filter, such as one of the laboratory filters, or build one out of an R/C circuit. Look at the filter output on both the oscilloscope and spectrum analyzer. Adjust the bandwidth to be as low as you can, while still clearly seeing where the high and low levels are on the oscilloscope (and without significantly changing their amplitude). Note how this effected the range of frequencies used by the signal on the spectrum analyzer.

11. Use the filtered square wave to modulate the 1 MHz signal. How much did the filter reduce the bandwidth of the modulated signal?

12. Now let's extract the data from the 1 MHz modulated signal. You can do this using an envelope detector as discussed in class. Build an envelope detector using a diode, capacitor and resistor. When the 1 kHz signal is a square wave, what RC time constant do you need in the envelope detector to get a reasonably good looking 1 kHz square wave at the envelope detector output?

13. What happens if the RC time constant in the envelope detector is too large? What happens if it is too small? What type of distortion at the envelope detector output seems impossible to remove?

14. Switch the 1 kHz signal back to a sine wave. Adjust the amplitude so the 1 MHz signal varies between 0.5 volts and 1.5 volts. Pass the modulated signal through the envelope detector, to try to recover the 1 kHz sine wave. Does this work? Watch for distortion from a poorly chosen RC time contact in the envelope detector. Also watch for clipping caused by the diode not having enough voltage to turn on / forward bias / when the amplitude of the 1 MHz signal is small.

15. Replace the 1 kHz sine wave with a voice or music signal. You can use the sound output jack from the PC. Determine if the RC time constant in the envelope detector is still working correctly. Explain how you have to change it if necessary.

16. If you have a commercial AM radio, tune it to 1,000 kHz, and place it next to your 1 MHz sine wave output. See if you can hear the audio signal coming out of the speaker.

17. What does the speaker of the AM radio produce if the voice or music is replaced by a 1 kHz sine wave? by a 1 kHz square wave? by a PN sequence?

18. Place a long wire on the oscilloscope input to act like an antenna. See if you can detect any local commercial radio broadcasters operating in the range of frequencies from 530 kHz to 1700 kHz.

19. Repeat the previous step, but use the spectrum analyzer rather than the oscilloscope.

20. Repeat the previous two steps, but look for radio stations transmitting between 88.1 MHz and 107.9 MHz.

21. Look for any other radio transmitters you can find with the spectrum analyzer, using the full range of frequencies it can detect.

22. The federal communications commission (FCC) regulates AM radio broadcasts. Have you been violating FCC regulations by broadcasting signals at 1 MHz during this lab? Explain.