Laboratory 7

Design of Square-Wave Oscillator and Amplitude Modulation

In ELEC 120, we designed a square-wave oscillator using operational amplifiers and 555 timers. In this lab we will use a 555 timer circuit with an operational amplifier circuit to make an amplitude modulation (AM) transmitter.

Preparation: Please answer these questions before coming to lab on December 4.

1. To get you started, a circuit is suggested in Bobrow (the text from ELEC 120), pp. 715-718 and 721-722. The 555 timer can be used in many different modes. In one useful mode, it can function as an "astable multivibrator." That means it will oscillate and generate square wave outputs without any external, timing input.
2. The basic circuit is shown in Bobrow on p. 717. In this circuit, the frequency is given by $1.443/((R_a +2 R_b)C)$. The "duty cycle" (that is the fraction of time it gives "1") is $(R_a+R_b)/(R_a +2 R_b)$. (Obviously, we cannot get square waves with this circuit that are "1" and "0" for equal times.)
3. Would you please study the datasheet for the 555 timer at http://www.national.com/ds/LM/LMC555.pdf ?
4. Please review your ELEC 120 lab notebook for 555 timer circuits.
5. Design a square-wave oscillator (astable operation) to oscillate at an adjustable frequency between 600 kHz and 900 kHz.
6. Design an operational amplifier circuit with a gain -10 volt/volt and a DC offset of 6 V. That is, the output voltage $v_o(t)$ and input voltage $v_i(t)$ are related by
   $$v_o(t) = -10 v_i(t) + 6 (V).$$
   Please see Figure 5.13 and equation (5.22) on p. 165 in the Nilsson/Riedel text.
7. What is the frequency band that is used for broadcasting of AM radio stations?
8. What is AM? How is it done? What is meant by the "carrier"? What is meant by the "modulation index"?
9. Plot an amplitude modulated signal with modulation index = 0.5 and carrier frequency 600 kHz. Let the modulating signal be $\cos(2\pi\ 1000\ t)$.

Lab Activities:

1. Build the circuit and test it.
2. Test the circuit using an AM radio to receive the signal generated by your circuit.
3. Try using a variety of signal sources in your testing, such as audio tones (sine waves with frequencies that we can hear), the PC soundcard, a microphone, etc.
4. Have fun.