6.101 Project Proposal - Henry Love & Nicholas Klugman

Introduction:

The purpose of this project is to created a unique, intuitive user interface to control the location of a cursor on a computer/display. The user interface is inspired by a touchpad/drawing board where the user will hold a stylus that controls the location of the mouse on the screen of a computer or some other type of display. One may use this interface to simply control their computer, or, to use in a more literal way, one may draw in MS paint using our set-up.

This project has three main elements, the drawing board, converting raw collected data into formatted/encoded data we can send to the display, and the connection between the drawing board and the computer/display. Additional features may be added to the project if time permits, such as an auto location button, where if pressed, the cursor would move to a fixed location on the screen. The connection between the board and the computer may be wireless, using a tank circuit similar to lab 1. An arduino will be used to interface with a computer if time permits.

Block Diagram

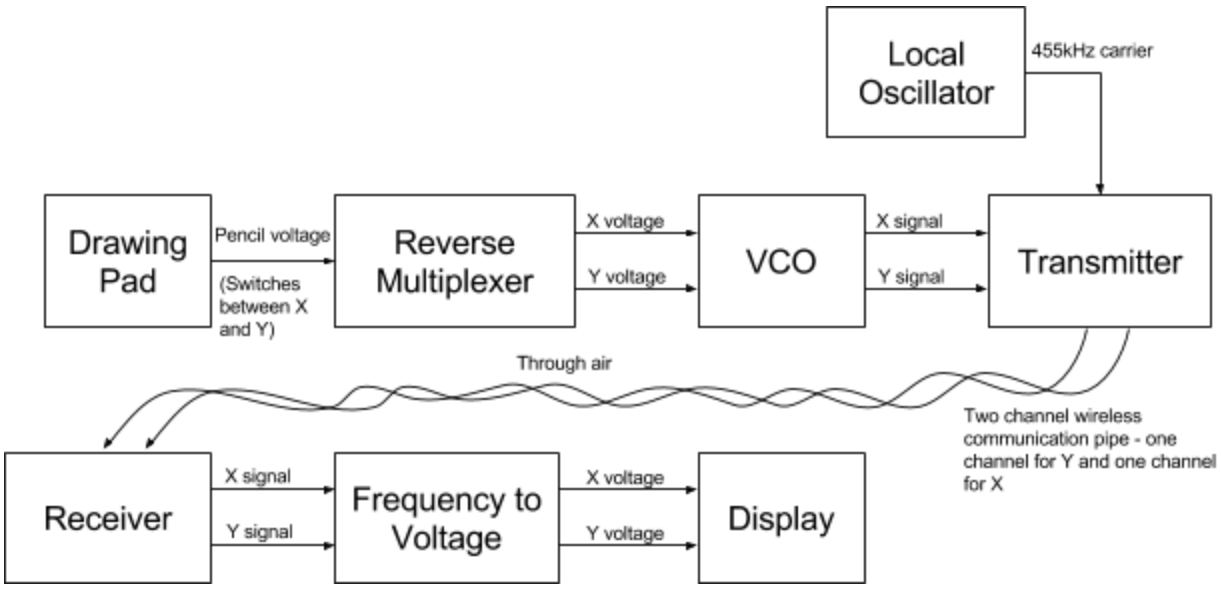

Figure 1. High level block diagram

Drawing Pad

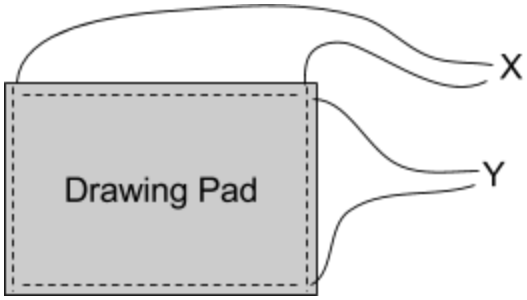

Figure 2. Drawing pad configuration

The drawing pad is composed of a piece of resistive paper. This paper has electrodes (bare wires) sewn into it to make an electric connection with each side. X and Y signals each have two wires; one for ground, and one for +15 volts.

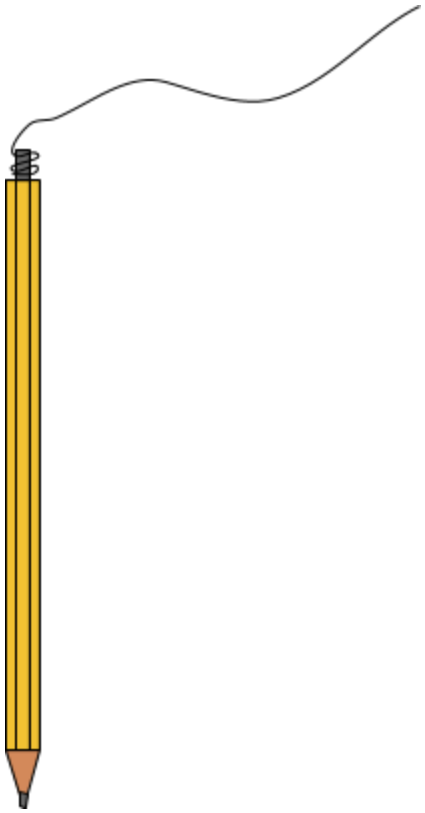

Figure 3. Pencil with wire attached

The stylus will be a classic wooden pencil with the back part shaved away - an electrode will be connected to the graphite in this location. Another electrode will be connected to the drawing board. The pencil will be used to “wipe” across the paper, akin to a potentiometer wiper, resulting in a output voltage from the wire attached to the pencil graphite. This voltage varies linearly with the position of the pencil on the paper.

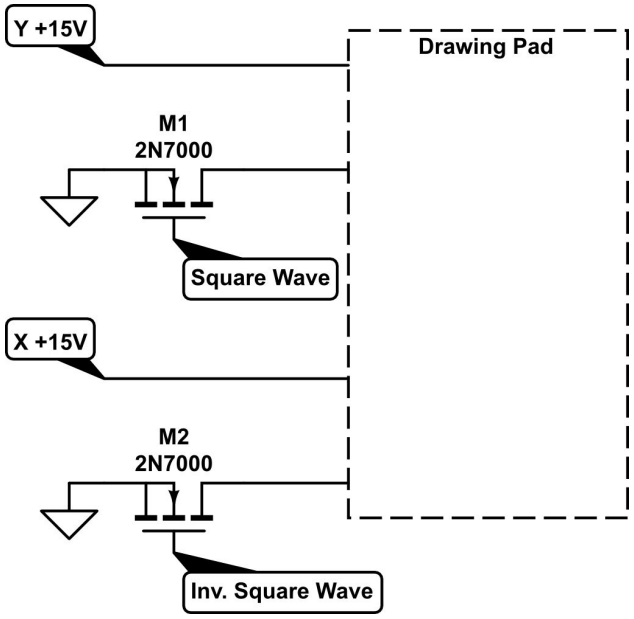

Figure 4. Drawing pad driver circuitry

Some driver circuitry must be used to ensure that the readings from the drawing pad is correct. Power can only be applied to one rail of the drawing pad at a time or else the voltage reading on the pencil will register a faulty measurement.

Reverse Multiplexer

The role of this module is to provide a steady output voltage for both X and Y that can be fed into the voltage controlled oscillator. X and Y voltages can only be read one at a time, therefore, a clever circuit must be employed to ensure that the X position reading does not interfere with the Y position reading and vice versa.

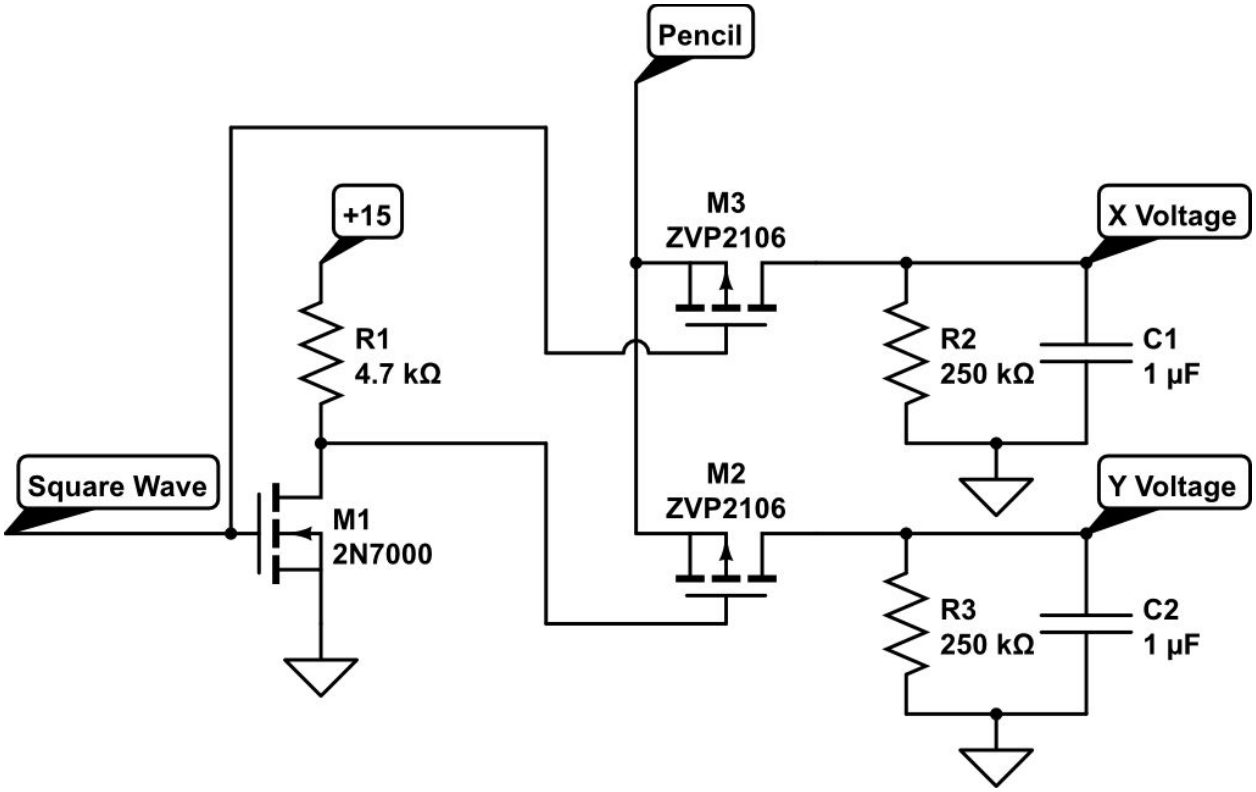

Figure 5. Reverse multiplexer

The square wave input provides a switching function such that half the time the X voltage is being read, and the other half the time the Y voltage is being read. This square wave is also used to switch the power between the X and Y rails on the drawing board.

X and Y voltages are stored in an RC network with a time constant of approximately ¼ of a second. This filters out switching frequencies while allowing the voltages to adjust within a reasonable amount of time. If, after testing, a time constant of ¼ of a second is not optimal, the resistor/capacitor values may be changed.

Voltage Controlled Oscillator

In this project, X, Y position of the pencil is encoded using frequency. The pencil-paper combination forms a voltage divider that produces a voltage that can be fed into a voltage controlled oscillator (VCO).

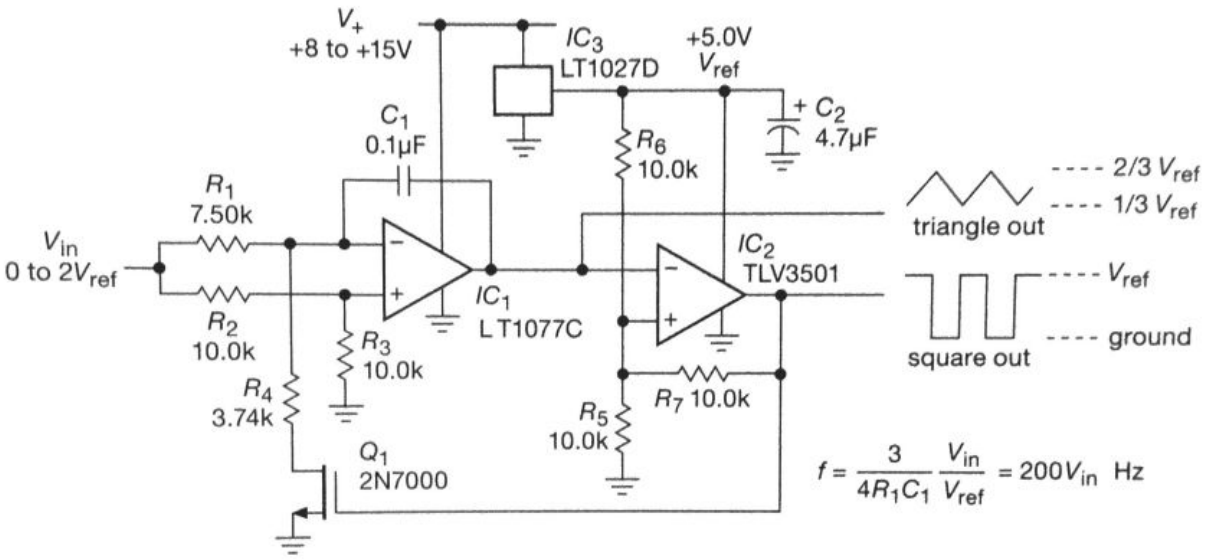

Figure 6. Voltage controlled oscillator from "The Art of Electronics"

Above is the circuit of the VCO used in this project. Some modifications were made, including the use of a LM6132 in place of IC1 and a LM311 in place of IC2. In addition, the Vref was made adjustable using a pot and a voltage follower. This allows for adjustable amplitude of the output wave, which could be useful for modulation depth (percent of AM modulation). The end goal is to produce an output sine wave, therefore the triangle output is used as less filtering has to be performed in order to make it look like a sine wave.

Local Oscillator

The role of the local oscillator is to create a carrier wave for the AM modulated signal to be transmitted. Due to component availability in the lab, carrier frequencies around 455kHz are being used to carry the modulated signal. A variety of circuit configurations were tested before settling on the final circuit - a Colpitts oscillator. The high frequency of this signal prevented the use of certain components/circuits, such as lower speed op-amps or a phase shift oscillator.

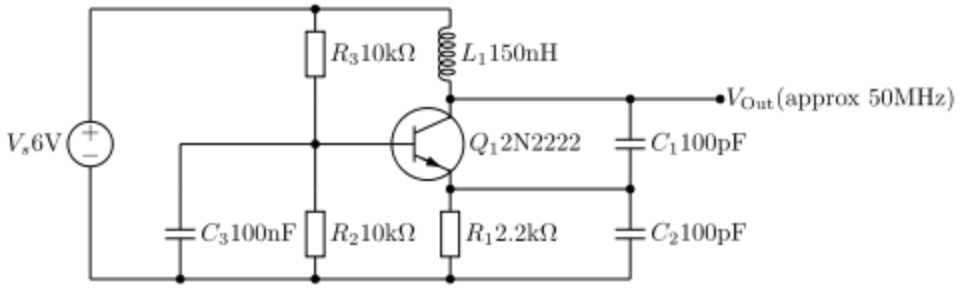

Figure 7. A Colpitts oscillator

The figure above shows the circuit configurations of the oscillator made. Component values were adjusted such that the output is 455kHz. The source is Wikipedia.

Transmitter and Receiver

The main focus of the project lies with the wireless transmission of the drawing board signal to the display. The signal from the drawing board is sent via amplitude modulation. For development, there are different communication schemes that are built upon each other and increase in complexity. Progress will be made sequentially to keep debugging at a minimum.

- One channel AM transmitter with manual switch for X, Y
- Two channel AM transmitter
- One channel AM transmitter that sends both X, and Y coordinates

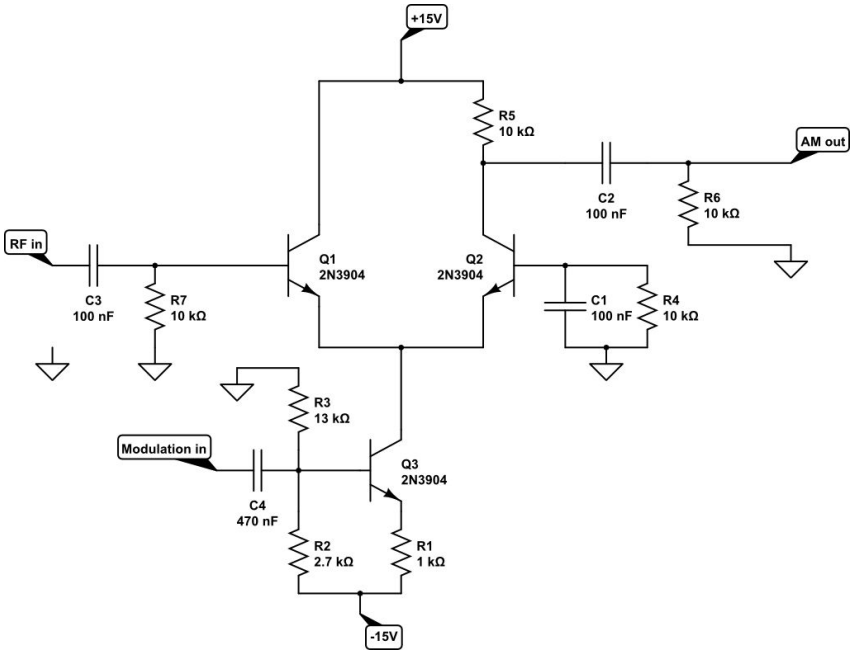

Figure 8. Transmitter

Above is the preliminary circuit for the AM transmitter. An antenna is connected to “AM out”, and the circuit also doubles as a mixer, mixing the RF carrier wave from the local oscillators with the signal output of the VCO. Q1 and Q2 are a matched pair, with very similar betas.

Frequency to Voltage Conversion

This module does the reverse of the VCO stated above. After filtering the carrier frequency from the received signal, the position of the pencil on the paper must be determined. This is done by mapping the frequency of the received signal to a voltage. As the frequency of the VCO ranges from 0Hz to 2kHz, this frequency to voltage converter must take a signal of frequency 0Hz to

2kHz and map that to a voltage. These circuits are commonly used in FM circuits, for demodulating the FM signal.

Display

The display displays the position of the pencil on a screen. As a base line, this display will be an oscilloscope in X,Y mode. Possible improvements include using an arduino to interface with a computer. A python script could be written to display the arduino output on a screen. As a stretch goal, a protocol such as PS/2 will be used to interface the drawing board with the computer. Since this is more digital than analog, this will not be investigated until all other goals have been met.

Conclusion

Our aim is to make an interesting, entertaining way to interact with a computer. By imitating something we do every day (write on paper), this computer interface should be very intuitive to use and easy for users to grasp. While one may use this in conjunction with MS paint to create digital drawings, it is also possible to use this set-up to control one's computer, just as you would be able to do with a mouse/touchpad. Using objects such as a pencil for the stylus will give a sense of familiarity to the project, however, in theory, anything that is conductive and that can opening many creative ways to use this platform as a user interface to a display.