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EE 320

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EE 320 final project Writeup

My final project consists of the following sections:

Part 1 Part 2

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| Clock source based on an op amp | DAC consisting of a NPN transistor and multiple 1.2 M resistors that attach to the LFSR LEDs |
| Comparator based on an op amp and a thermistor that changes clock speed and brightness of an LED | VCO based on a programmable unijunction transistor. |
| LFSR based on 2 74hc595 and a 74hc86 quad XOR gate. Connected to 16 LEDs each with a series resistor | FM transmitter based on a Colpitts oscillator |

The circuit is split into two main parts which are for the most part independent from each other.

Part 1: An LFSR is driven from a clock source derived from an op amp. The feedback for the LFSR is achieved with jumper wires to allow changing of the polynomial easily. The LFSR clock source is configured as a VCO but with a limited range. Its frequency rises when the thermistor reaches a set temperature level. This temperature level is controlled by varying the reference voltage to an op amp configured as a comparator. The output of the comparator feeds into another op amp configured as a constant current LED driver. This LED signals that the temperature level has been reached. Leakage from the clock source into the constant current driver makes the LED blink dimly with each clock pulse when the temperature level has not been reached. This is not a bug but a feature that visually shows the clock speed.

Part 2: A VCO is made using a programmable unijunction transistor. This generates a sawtooth wave at a variable frequency. A transistor is shunted across the voltage supplied to the oscillator such that an increase in current through the transistor will reduce the voltage going to the oscillator, reducing its frequency. The transistor’s base is connected via a potentiometer to three 1.2 M resistors that go to 3 different LEDs from the LFSR. The resistors sum the voltages from the LEDs and this is used to vary the current going through the shunt transistor. The more LEDs that are on, the more current that flows through the shunt transistor and the lower the frequency of the VCO. The output of the VCO is connected to the audio input of the FM transistor via a high impedance JFET buffer. The FM transmitter consists of a Colpitts oscillator with a high Q tuned circuit in the collector. The feedback via a 10pf cap from the collector to the emitter. From an RF stand point the base is grounded but audio is still able to influence it. The audio changes the working point of the transistor and therefore the frequency at which it oscillates. The working point of the transistor is set by a 50k pot.

The circuit is powered by a single lithium cell and a small battery management/ charging board is included to keep the lithium cell happy. The charging board has a micro USB port on it for power.

Troubleshooting:

It turned out that some of the transistor pinouts were not correct. The JFET and the voltage regulator had to have their pins bent to correct the layout.

Initially the LFSR clock did not run, I discovered that I had installed the resistor going from the feedback potentiometer was going to the positive rail instead of the output of the op amp. This resistor was removed and was soldered to a close trace connected to the correct pin. Once the clock was running it was discovered to be unstable, however if I touched two pins of the op amp with my hand the circuit would be stable. A 1.2 M was connected from the positive rail to the center tap of the feedback potentiometer.

The variable capacitor and coil for the transmitter turned out to be too big for the pads allocated. A piece of solder braid was used to make a low impedance trace to connect the two components.

Once those bugs were fixed the circuit function is identical to the prototype version with the exception that the FM transmitter is a lot more stable due to the boards ground plane.

