Lab 5: Operational Amplifier Application
Electronic Security System Part 2 of 2

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ECEN 214 - 502

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Procedure

1. Rebuild the security system from where you left off in lab 4.
2. Make sure that the comparator outputs 5 V when the light beam is unobstructed and 0 V when the light beam is obstructed.
3. Build the circuit shown in figure 5.6 (latch)
4. Connect the output of your circuit to the circuit you build in step 3
5. Connect the output of the latch to the indicator LEDs
6. Make sure that the circuit functions properly and the LEDs turn on and off at the appropriate times.

Overview

The security system that we built has 6 major parts. The first one is the IR emitter. It emits infrared light.

Second is the IR detector. This outputs a current when it detects an infrared light. It will output no current when there is no infrared light.

Next there is the current to voltage converter. This is achieved by putting the output of the IR detector into the negative input of an op amp.

The fourth component is the signal amplifier. Using a second inverting operational amplifier we were able to amplify the created voltage fed in by the current to voltage converter.

Once we amplified the signal to sufficiently high values, we fed the voltage into a voltage comparator. We put the input on the positive input and the reference voltage on the negative input of the op amp. This made it so that the signal was a logical high when the light beam was unobstructed and logical low when it was obstructed.

The last component in our security system was the SR latch which was the memory component that kept the red or green LED on or off at the correct times.

After we got all components working correctly, the security system would turn on the green LED until the light was obstructed, at which point it would turn off the green LED and turn off the red LED until the system was reset.

Discussion

For our emitter we used a 400 ohm resistor. This gave us the strongest signal.

For our current to voltage converter we utilized an inverting operational amplifier and used a 5000 ohm resistor because this was the value that we arrived at in lab 4.

Since this inverting amplifier left us with a negative voltage values, we also used an inverting amplifier for our signal amplifier to turn our signal back to a positive value. We chose an amplification value of 3.3, using a 3300 ohm resistor for R2 and a 1000 ohm resistor for R1.

For our comparator we used 2.6 V as our reference voltage and put it on the negative input. We arrived at this value during the last part of lab 4. Due to our choice of reference voltage, inputs below 2.6 V resulted in logical low being output, and inputs above 2.6 V resulted in logical high being output. As previously noted, due to our choice of comparator, the signal voltage goes on the positive terminal and the reference voltage goes on the negative terminal.

Measurements

Task 1

Unobstructed	Obstructed
.212 mV	4.966 V

Task 2

Action	Voltage at SR Latch
Reset latch	.134 mV
Obstructed IR	4.422 V
Removed obstruction	4.422 V

Conclusion

This lab was very complicated and forced us to use all of the things we had learned thus far in ECEN 214. As discussed in the overview, there were several different components that were required to function together. As most of the labs up until this point had been only one or two components, it was a challenging exercise to get all of the different parts to work correctly. The breadboarding also got a bit complicated, but keeping our workspace neat and organized we were able to navigate

through the lab step by step and complete everything successfully. Our circuit functioned perfectly, turning off and on the correct LEDs at the appropriate times.

Working with our circuit, we learned that the emitter and LED could be at most ~75 mm apart while the security system still functioned correctly. We experienced no false alarms or missed detections. We used different types of obstructions for different amounts of time and they all worked perfectly, giving us confidence that our circuit worked properly.