Hussein (Shawn) El-Souri

4124 1447

≃ 5.6 v on motor in dark conditions

Project WORKED AS REQUESTED
NO VCO WAS USED

Contents

1) Procedure

Similar to project 1 an operational amplifier is to be used in this project. The difference however the inverting input of this operational amplifier is connected to a phototransistor. Recall at first the pinout of an operational amplifier in Figure 1 :

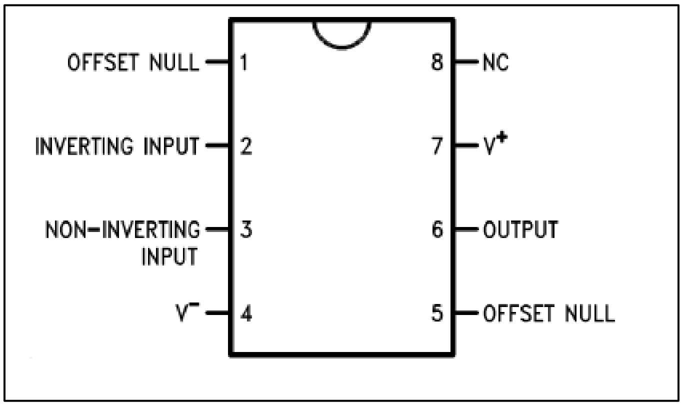

Figure 1 : LM 741 pinout

Recall also that a phototransistor is basically a transistor in which the base can receive light as input (Check Figure 2 for phototransistor pinout)

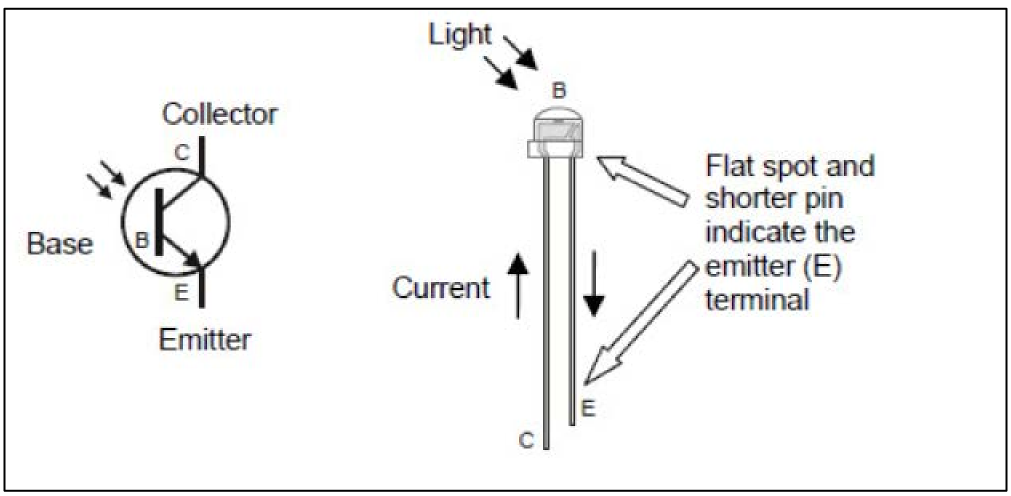

Figure 2 : Photo Transistor Pinout

The phototransistor is characterized such that the value of the current it outputs during light and dark is noted. The characterizations have to be taken into consideration such that when the phototransistor is in dark light conditions it transmits 6 v to the motor. On the other hand a very small voltage (close to zero is transmitted to the motor when the phototransistor is exposed to bright light. This is why the phototransistor is connected to the inverting input.

To accomplish this we also need to attach the output of the OP-AMP to the base of a 2N3904 transistor (check Figure 3 for pinout)

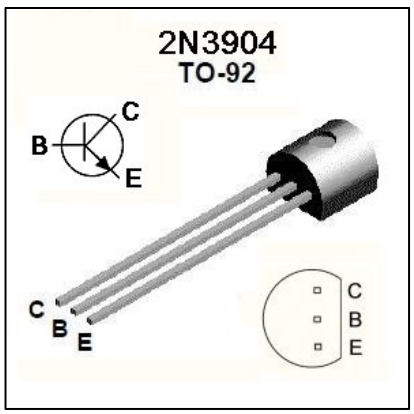

Figure 3: 2N3904 Pinout

The collector is connected to $+V_{cc}$ and the emitter is connected to the motor. A feedback resistor is also connected between emitter and the inverting input of the op-amp. The noninverting input of the op-amp is connected to a dc current that offsets the voltage and allows a workaround to the possible 0 v at the motor which will affect op-am biasing. The phototransistor is also connected to $+V_{cc}$ to forward bias the transistor and ensure proper am amp operation.

2) Physical Circuit and LTSpice

Inserted here is an image of the physical circuit (Figure 4)

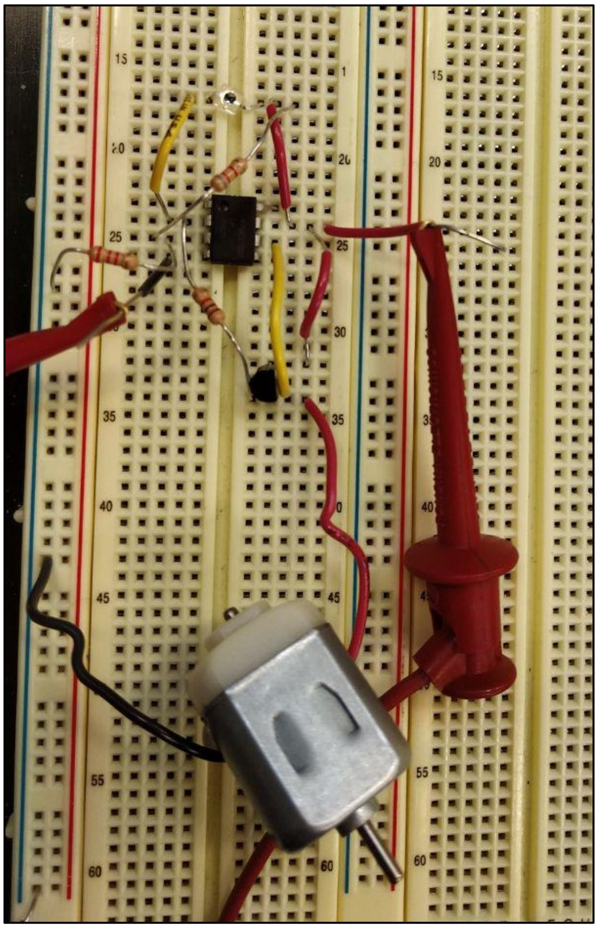

Figure 4: Physical Build

Physical build details: Inverting input of op-amp is connected to one lead of phototransistor with the other end connected to $+V_{cc}$=12V($+V_{cc}$ is also provided to collector). That node is also connected to a 1KΩ resistor with the other end connected to the emitter of the transistor. The non-inverting input is connected to an offset voltage = 6v. That offset is created by a simple voltage divider hence the presence of 2 more resistors. The output of the op-amp is connected to the base of the transistor. Recall also to properly bias the op-amp where $–V_{cc}$= 12v.

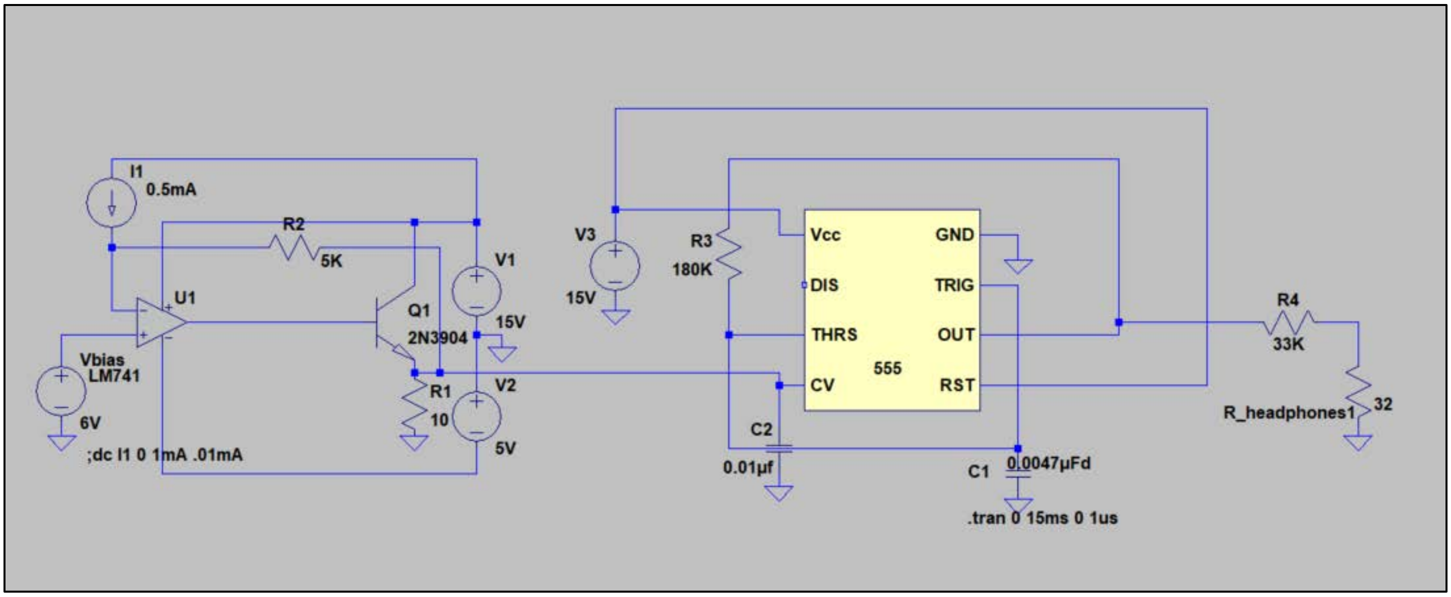

Figure 5: High Light Schematic

Figure 5 shows the schematic for the high light where the expected frequency output is expected to be 1.5 KHz.

Figure 7 shows the voltage along the output voltage while Figure 6 shows the measurements performed in this graph.

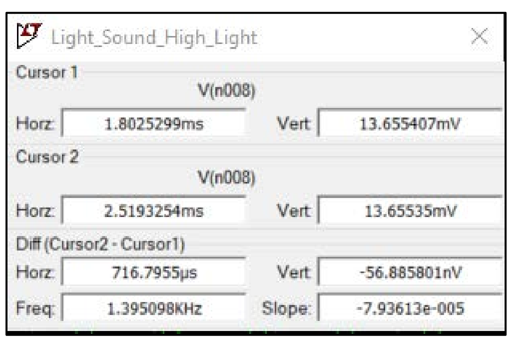

Figure 6: High Ligh Measurments

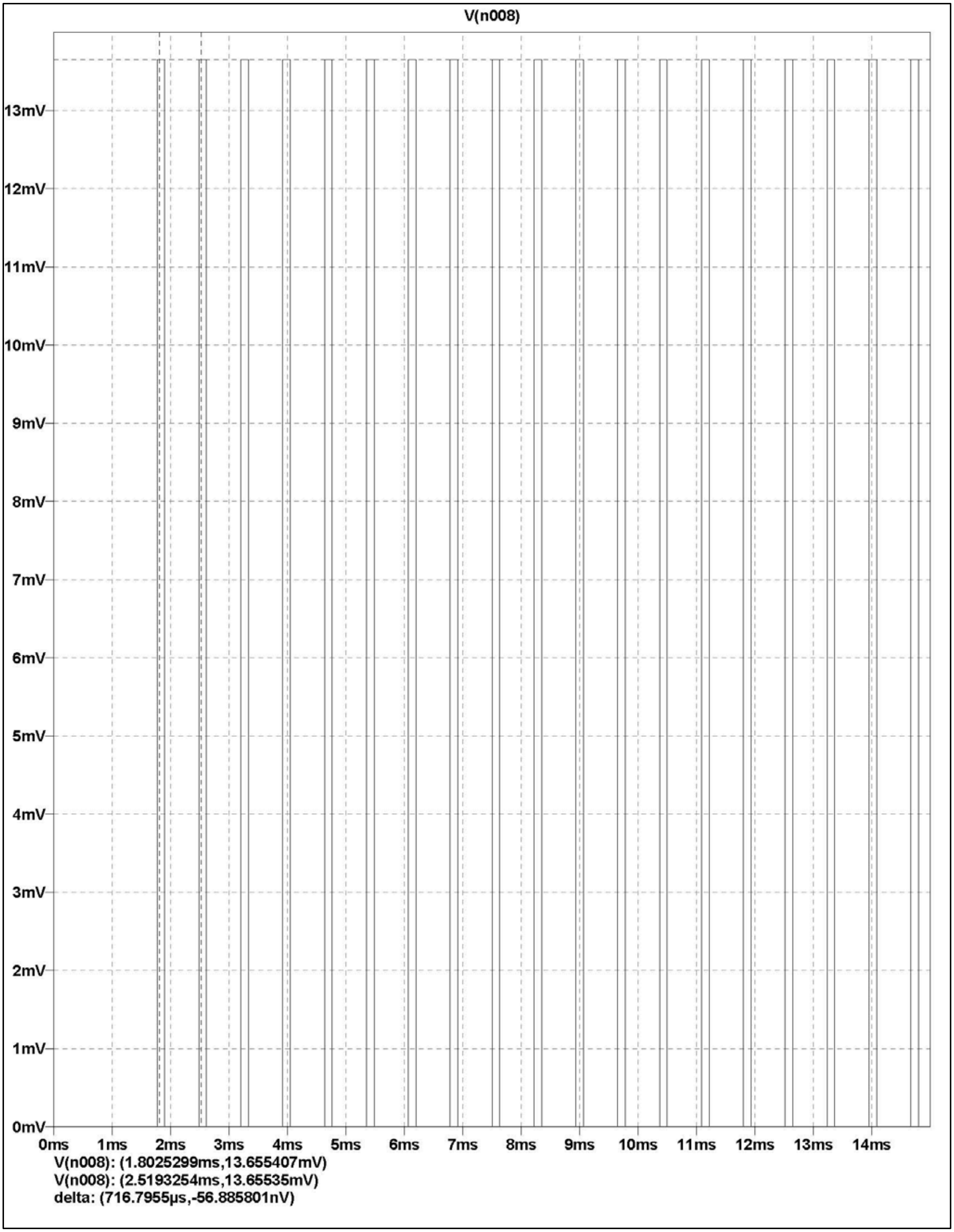

Figure 7: Frequency for high light

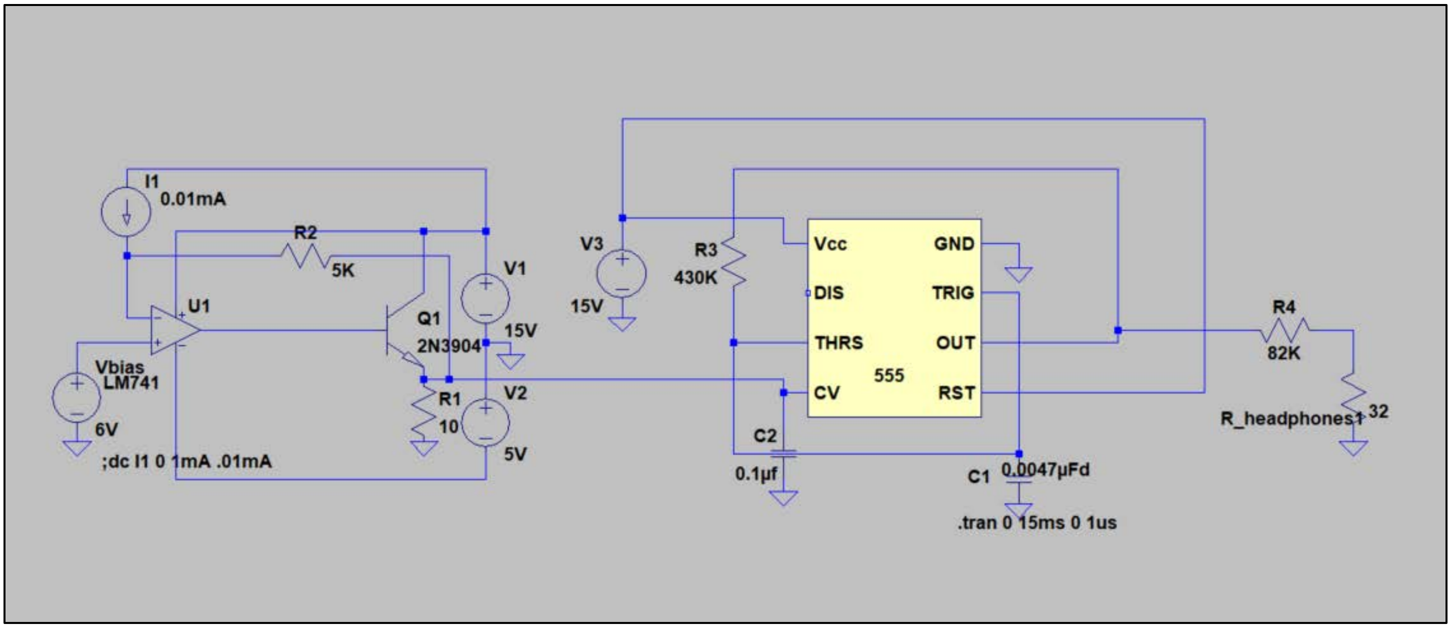

Figure 8: Low Light Schematic

Figure 8 shows the schematic for the low light where the expected frequency output is expected to be 500Hz.

Figure 10 shows the voltage along the output voltage while Figure 9 shows the measurements performed in this graph.

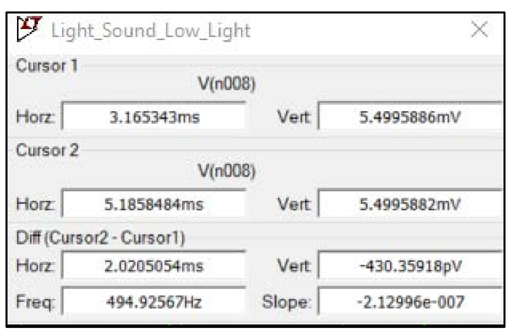

Figure 9: Low light Measurements

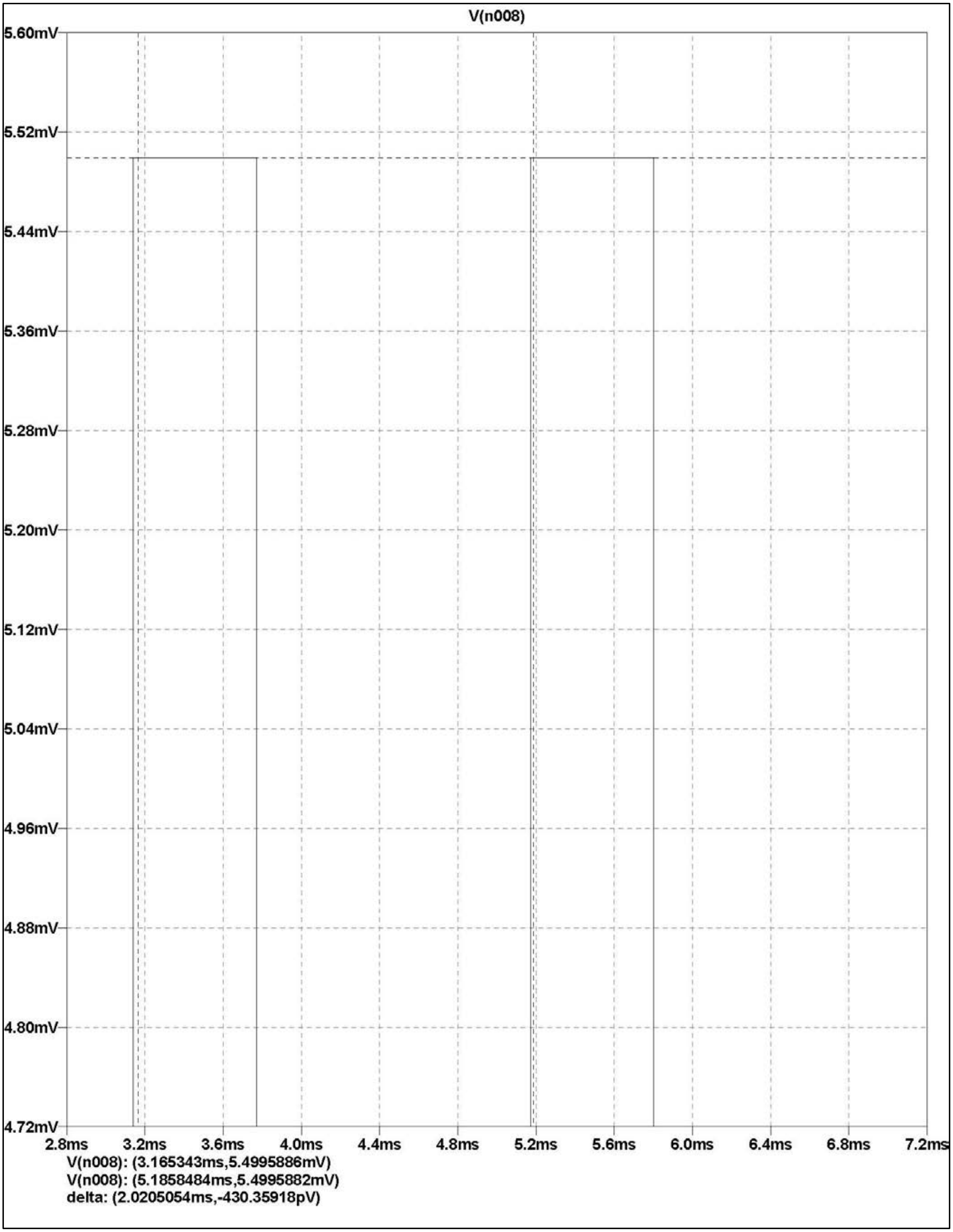

Figure 10: Low Light Frequency Remarks

3) Conclusion

It is always important to be able to read pinout of components, even if they are totally new to the user. It is also important to be vigilant of components that need biasing and be able to perform that operation normally. Attempting to connect the entire circuit in one try is unadvisable. One can rather connect the circuit by parts testing small part for functionality beforehand. For example before using an op amp one might try biasing it constructing a simple circuit to verify that the component is not faulty. Doing this process for all the major elements will eliminate any error from faulty (burnt) components. Otherwise the motor part of this project is fairly simple and straightforward.

4) Remarks

A fair mention that the audio part of the lab was only satisfied by changing component values because I honestly did not know how else to do it.
This project presented many challenges mainly due to unfamiliarity with the required task especially for the second part. However I attempted as much as possible to retain real life values of resistors.

5) Sources

http://www.ti.com/lit/ds/symlink/lm741.pdf #LM741

https://learn.parallax.com/tutorials/robot/shield-bot/robotics-board-education-shield-arduino/chapter-6-light-sensitive-15 #PhotoTransistor

https://commons.wikimedia.org/w/index.php?curid=16210769 #Transistor_2N3904

https://ecee.colorado.edu/~mcclurel/resistorsandcaps.pdf #Values