Lab 4: Preliminary IR Transmitter/Receiver Development

Prelab Questions:

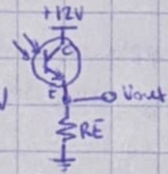
Q1 – $\frac{12-1.35\,[V]}{100mA} = 106.5\Omega$ are required for the given design specifications

Q2 – $P = I^2R = (100mA)^2(106.5\Omega) = 1.065$ Watts will be absorbed by the resistor

Q3 – $\frac{12V}{R_E} = \frac{12V}{50000\Omega} = I = 240\,uA$ through the potentiometer

Q4 – V@0 ohm = 12V V@50k ohm = 0V range = 0V to 12 V

1. Construct Light meter circuit



RE ~~1MΩ~~ Vout ambient = ~~2.8675 V 11.~~ ~~11.394 V~~ 9.276V

RE Vout covered = ~~minimal drop~~ 0.33331V

RE Vout partially covered = almost no change

RE Vout higher light Intensity = significant voltage increase

~~0.5k~~0.31kΩ Vout ambient 24.496 mV

~~RE Vout ambient~~

1MΩ ambient = 11.394V

RE = ~~15kΩ~~

RE = 0.39855 MΩ using Potentiometer

RE = 507.96 kΩ

Vout drops when the oscilloscope is connected

AC Coupling

Freq: 8.10 MHz

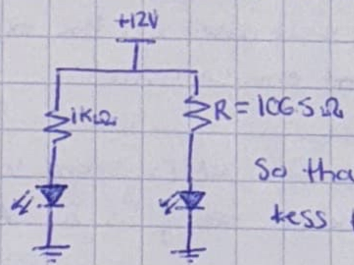
AC RMS – Cyc: 73.5mV

Period: 123.5nS

Avg – Cyc: –139.2mV

100(73.5/(2×139.2)) = 26.40%

2. Construct IR Light Source



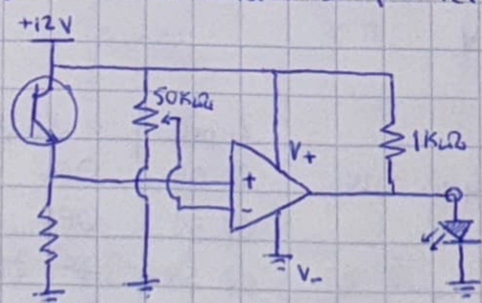
The 1kΩ will be exchanged for 5 200Ω

The 106.5Ω will be exchanged for 4 24Ω and 1 10Ω

So that the power dissipated by each resistor is less than 1/4 Watt

Distance	Voltage (Ambient Light)
0 in	11.9415 V
1 in	11.8310 V
2 in	11.8190 V
3 in	~~8.8~~ 11.8670 V
4 in	11.8101 V
5 in	11.2364 V
6 in	10.910 V
1ft	~~9~~ 10.0237V
2ft	9.7774 V

3. Construct simple reciever



The voltage across the potentiometer is 10.3206 V = Reference Voltage

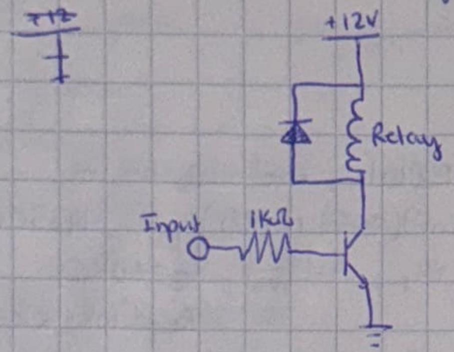
The range of the Reciever / Transmitter system is limited by the length of the wires connected to the power supply

The LED's brightness did not seem to be affected by the distance between the transmitter and reciever

Ambient Lighting may have influenced the reading of the phototransistor

Lab 4: Continued

Connecting the circuit to the Relay



The output of the OP Amp is connected to the Input of the BJT.

10/21

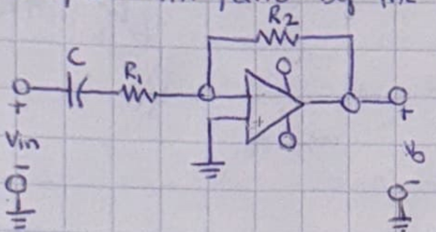
Lab 5: IR Remote Control Development Part 1

Prelab Questions:

Q1 - $\frac{9V-0.3V}{75mA} = 116\Omega = R$

Q2 - Since Period $= 0.693C_T(R1+2R2) = \frac{1}{f}$, $R1 > 1K\Omega$, and $C_T \geq 1nF$, the value for $R1 = 2K\Omega$, $C_T = 1nF$, and by the given equation $\frac{1}{5KHz} = 0.693(1nF)(2K\Omega + 2(R2))$, $R2 = 143300\Omega$

Q3-



$f_o = 1/(2\pi R_{eq} C)$, $R_{eq} = R_E + R_1$, $A = \left|\frac{R_2}{R_{eq}}\right|$, $R_E = 10K\Omega$

$f_o = 10KHz$

$R_{eq} = 10K + 40K = 50K\Omega$

IF $R_2 = 500K$

$A = 10 = \left|\frac{R_2}{10K+R_1}\right| \rightarrow R_2 = 100K + 10R_1$ ∴ $500K - 100K = 10R_1$, $40K = R_1$ Max

$f_o = 10KHz = 1/(2\pi(50K)C) \rightarrow C = 0.32nF < 0.5nF$ X

$f_o = 10KHz = 1/(2\pi(15K)C) \rightarrow C = 1.1nF > 0.5nF$ & $< 0.1\mu F$ ✓

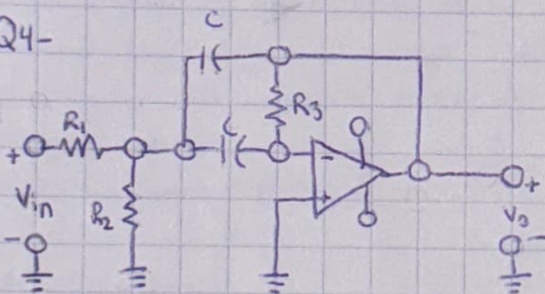
$15K - 10K = 5K\Omega = R_1 > 1K\Omega$ & $< 500K\Omega$ ✓

$100K + 10(5K) = 150K = R_2 > 1K\Omega$ & $< 500K\Omega$ ✓

$\left|\frac{150K}{10K+5K}\right| = 10 = A$ ✓

where $R_1 = 5K\Omega$, $R_2 = 150K\Omega$ and $C = 1.1nF$

Q4-



$10 = H_o = H(f = f_o) = \frac{R_3}{2R_1}$, $Q = \frac{f_o}{B}$, $R_3 = \frac{Q}{\pi f_o C}$, $R_1 = \frac{R_3}{2H_o}$, $R_2 = \frac{R_3}{4Q^2 - 2H_o}$

$Q = 10$ $f_o = 7.5KHz$ LET $C = 2nF$

$R_3 = \frac{10}{\pi(7.5KHz)(2nF)} = 212206.6\Omega$

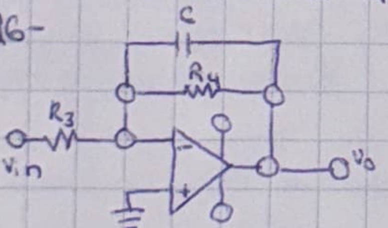
$R_1 = \frac{212206.6}{2(10)} = 10610.3\Omega$

$R_2 = \frac{212206.6}{4(10)^2 - 2(10)}$ 558.4Ω

where $R_1 = 10.6K\Omega$, $R_2 = 560\Omega$, $R_3 = 210K\Omega$, and $C = 2nF$

Q5 - Since $A = \frac{R_2}{R_1}$, a gain of 5 can be achieved by the rectifier by using an R_2 that is 5 times the value of R_1. Using the resistor constraints ($1 < R < 100K$), $R1 = 1K\Omega$ and $R_2 = 5K\Omega$

Q6-



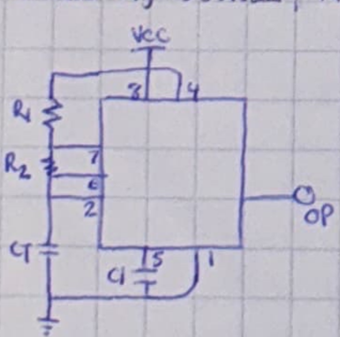
$f_o = 1/(2\pi R_4 C)$ $R_4 C < 0.1s$, $5 < f_o < 20Hz$, $A = \frac{R_4}{R_3}$, $R_4 \sim 1M\Omega$

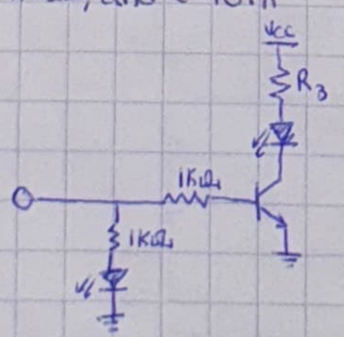
$0.01s = 1M\Omega(C) \rightarrow C = 10nF$

$f_o = 1/(2\pi(0.01)) = 15.9Hz < 20Hz$ & $> 5Hz$ ✓

$A = 3 = \frac{1M\Omega}{R_3} \rightarrow R_3 = 333K\Omega$

where $R_3 = 333K\Omega$, $R_4 = 1M\Omega$, and $C = 10nF$



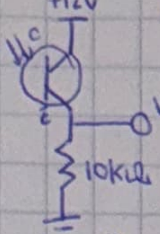


The observed frequency is ~~5.34KHz~~ ~~4.78KHz~~ 4.895KHz and the LED remains lit. R_3 is not constructed on Circuit Board 2211#4

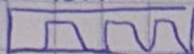
Where $VCC = 9V$, $R_1 = 1K$, $R_2 = ~~4.7K~~$ $6.2K$, $C_T = ~~25nF~~$ $22nF$, $C1 = 0.1\mu F$

15 15

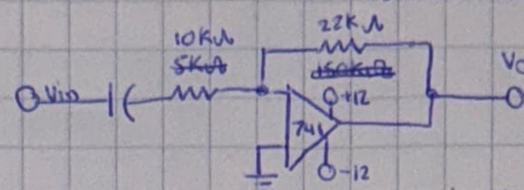
1st Block



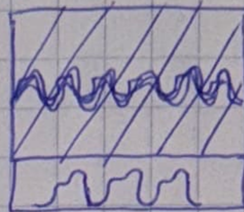
No recognizable waveform



2nd Block: High pass

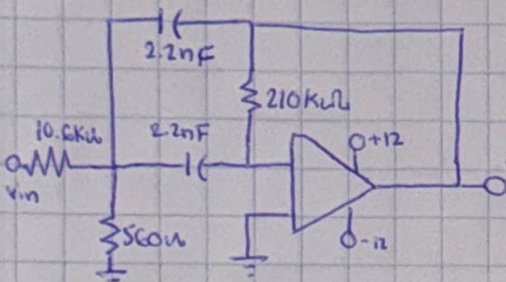


Wave form:

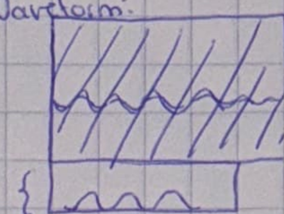


The noise when analyzing vout1 is greater than the noise when measuring vout2 with the oscilloscope. The high pass amplifier refines the signal from vout1 (smaller, sinusoidal) $f_0 = 4.5\text{kHz}$

3rd Block: Bandpass



Waveform:



3.6765 kHz from oscilloscope

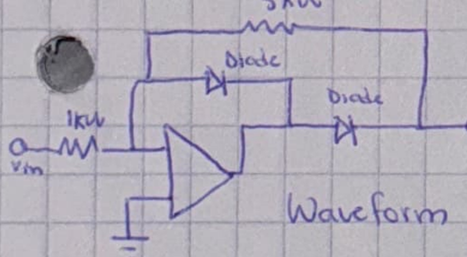
The bandpass filter is further from vout 2 resulting in a cleaner sinusoidal waveform. $H_0 = \frac{R_3}{2R_1} = 9.91$

~~$f_0 = 7.5\text{kHz}$~~

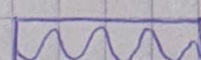
$f_0 = 4.9\text{kHz}$, $R3 = 295\text{k}\Omega$, $R_1 = 14.7\text{k}\Omega$, $R_2 = 777\Omega$

Matlab: The bandpass.m and setup_equip.m files are now obsolete as Matlab has switched from supporting the visa interface to the visadev interface upon converting, the setup_equip.m requires an unknown argument.

4th Block: Rectifier



Waveform



3.6765KHz

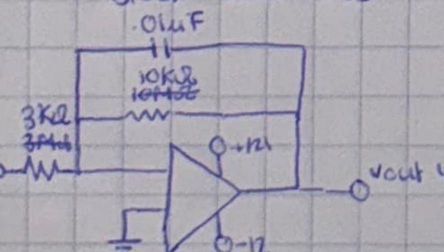
The rectifier ~~further smooths the~~ ~~transforms the~~ smooths the sinusoidal waveform from further ~~sinusoidal to square~~ The frequency of the waveform is the same as the waveform observed leaving the bandpass filter. As the transmitter was moved away from the receiver the amplitude increased. The rectifier is clipped for higher frequencies since the waveform has passed through the highpass filter.

5


@ $R_2 =$ ~~5k~~ $4.7\text{k}\Omega$

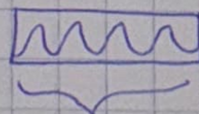
~~@ $R_2 = 3.3\text{k}\Omega$~~

5th Block: Low Pass



Waveform:

$f_0 =$ ~~5Hz~~ 5KHz



$f_0 = 3.6765\text{KHz}$ from oscilloscope

Similarly the low pass ~~amp~~ filter smooths out the sinusoidal waveform and has the same frequency as the previous waveforms. The gain is $\frac{R4}{R3} = 3.3$. It would not matter if the waveform was clipped for higher intensities because the low pass filter only allows frequencies lower than its frequency.

(Lab 5 Continued)