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EEE313 LAB REPORT 1

Introduction:

The objective of this lab report is to generate a DC voltage at the output node and find appropriate R2, R3 and C1 values by understanding the working principle of infrared LED, photodiode, transimpedance amplifier, and a envelope detector circuit. The circuit is demonstrated in Fig1.1.

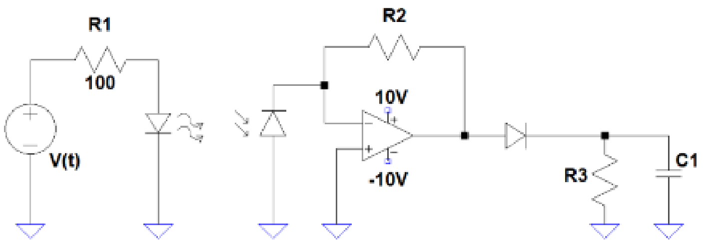

Fig1.1 The circuit

The components of the circuit is listed as following:

1) SB-5010IRB IR LED: This component can be seen at the left hand side of the circuit. The typical forward voltage of this component is 1.5V. It emits infrared light with a wavelenght of 940nm.
2) PD333-3B/H0/L2 Photodiode: Generates a 35µA current regularly with a minimum current value of 25µA. Operates with the same wavelength range of infrared LED.
3) LM324 OPAMP.
4) 1N4148 Diode.

The working principle of the circuit can be divided into 3 parts. The first part consists of emitting-absorbing infrared light. When forward voltge of IR LED is exceeded, IR LED emits infrared light and phtodiode detects the infrared since the emitted light is typicaly 940nm. After the detection, photodiode outputs a current. The reason behind using IR light is to prevent any impact of visible light, which. is present in the lab medium, on the experiment. Second part is establishing a transimpedance amplifier circuit. This part is essential in order to generate a voltage at the output of the opamp. The tansimpedance amplifier circuit consists of LM324 and R2. The final part is required to obtain a constant voltage at the output node. The circuit is classified as a envelope detector circuit and consists of 1N4148 didode,R3, and C1.

Hardware Implementation and Analysis:

The signal generator is set to 3sin(2π*1000) and forward voltage of infrared is checked by examining the p side node of the infrared LED. One of the important point in hardware implemetation is to keep photodiode and IR LED close to each other as possible in order to prevent any type of error.

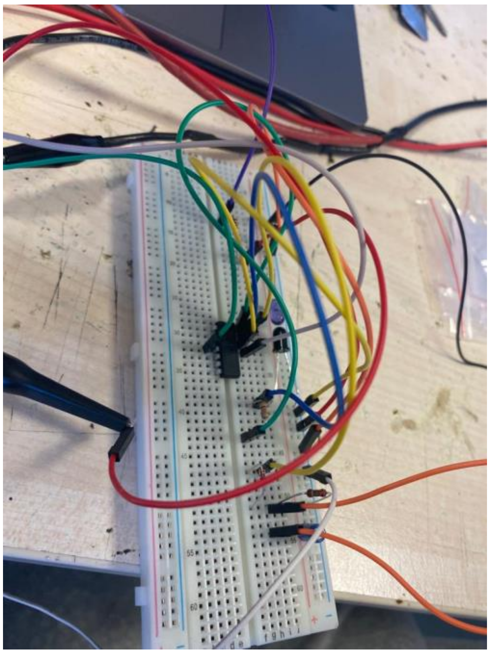

Fig2.1 hardware implementation of the circuit

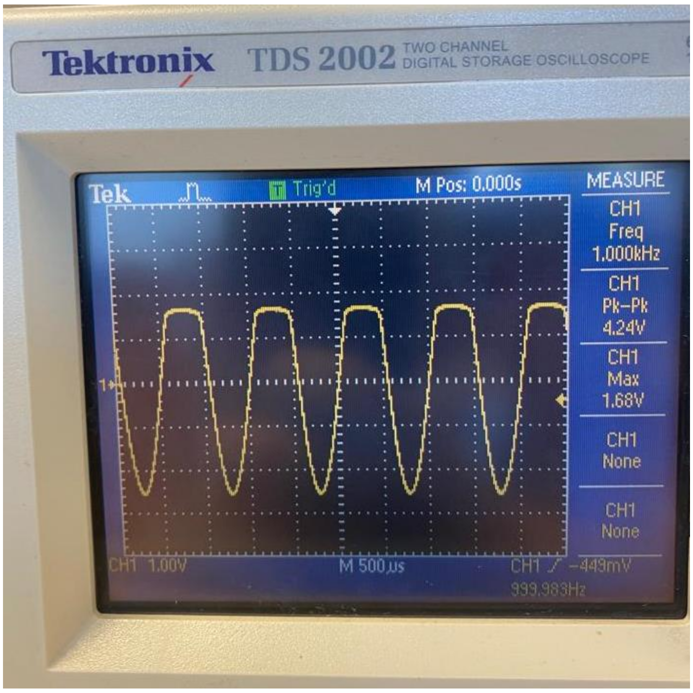

Fig2.2 output at the p side node of the IR LED

As it can be seen IR LED operates with a forward voltage of 1.68V. After checking whether IR LED is operating, the output of the transimpedance circuit is investigated. Due to connecting p side of the photodiode to the ground, the induced current is directed toward R2. The potential diffrenece between R2 should be within the range of -10V and 10V which is saturation range of the opamp.

$$V_{-} = V_{+} = 0, \text{Therefore}$$

$$V_{opamp} = I_{induced} * R2$$

$$-10V \leq I_{induced} * R2 \leq 10V$$

$$I_{induced} = 35\mu A$$

$$0 \leq R2 \leq 285k\Omega$$

R2 is selected as 10kΩ and the inequality $-10V \leq V_{opamp} \leq 10V$ is satisfied. Now, experimental value of $I_{induced}$will be observed by looking at the p side node of 1N4148.

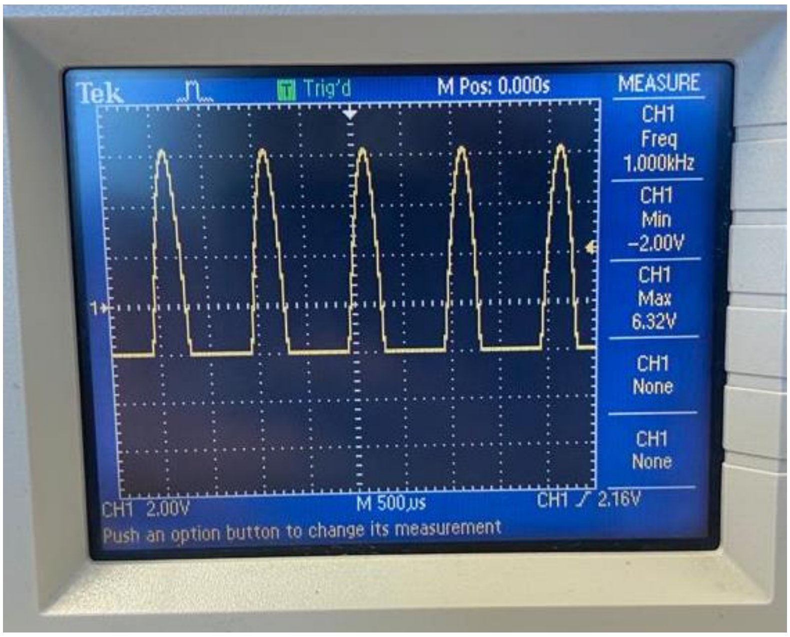

Fig2.3 output at p side of 1N4148 diode.

$$I_{induced} = \frac{V_{opamp}}{R2} = \frac{6.32V}{10k\Omega} = 632\mu A$$

The generated current by photodiode is calculated as $116\mu A$. Also by observing the output the waveform is not truncated sinus therefore it can be interpreted that opamp operates in the linear reigon which means that R2 value is appropriate for the desired transimpedance amplifier circuit.

Moving onto the last part which is determinig the values of R3 and C1 which are present in the enveloper detector circuit. From the datasheet of the 1N4148 didode the forward voltage is 1.0V at maximum. The diode turns on when the output of greater than forward voltage value. After the diode is turned on chargimg process of the capacitor starts and the capacitor discharges when the output voltage of the amplifier is less than forward voltage of the diode. Charging and discharging of the capacitor generates a ripple voltge which has a frequency determined by time constant of the envelope detector circuit. The time constant should be much more gretaer than the input frequency in order to obtain a DC voltage at the output node. Time constant is determined as following.

$$\tau = R3 * C1 \gg 0.001s$$

$$R3 = 1.2M\Omega, C1 = 2.2\mu F$$

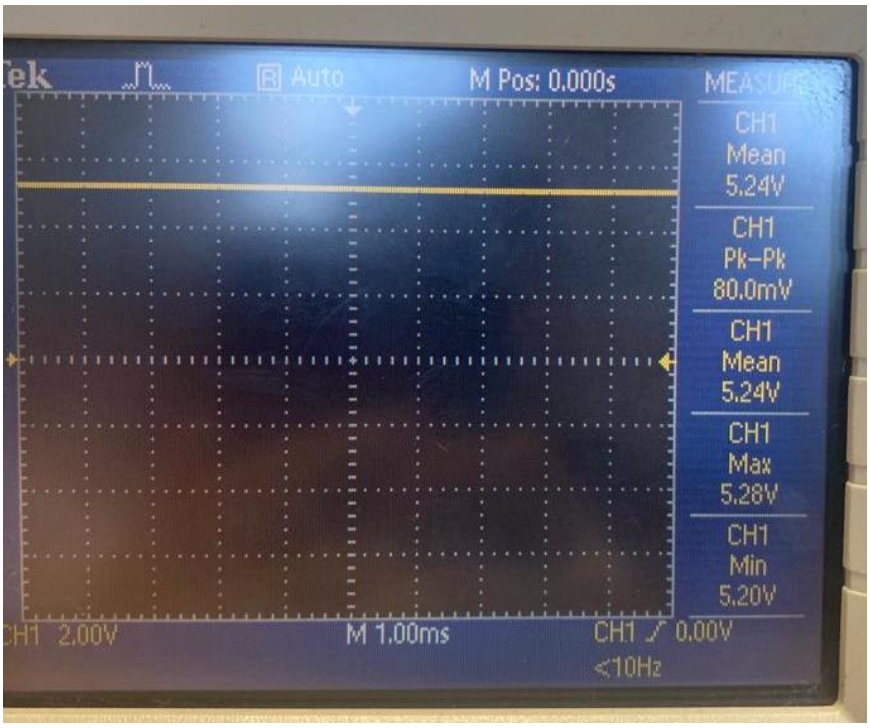

Fig2.4 the output voltage

As it can be observed, 5.28V volt with a 0.08V is obtained as desired. It is also important to highlight that the diference between the max observed value in Fig2.3 and Fig2.4 gives the turn on voltage for the 1N4148 diode which is 6.32V-5.28V=1.04V. The circuit works as desired.

Conclusion:

This lab is useful to familiarize students with electronic components such as photodiode, IR LED, opamp, 1N4148 diode. Besides familiarizing with electronic components this experiment also forces students to gain knowladge about certain circuits such as envelope detector and transimpedance circuits. The circuits is implemented accordingly as 3 parts(IR LED-photodiode, transimpedance amplifier, envelope detector circuit) and observed. It has come to a conclusion that the circuit operates as desired due to obtaining desired outputs.

References:

1https://www.datasheets360.com/part/detail/sb-5010irb/-2239340989605240855/

2) https://www.mouser.com/datasheet/2/143/PD333-3B-H0-L2_datasheet-9394.pdf

3) https://www.vishay.com/docs/81857/1n4148.pdf