Lab 4: PhotoDiodes and Optical Link

Gabriel Ralph: 470205736
Liam Weichandt: 500463727

Part 1

The GL4800E0000F Infrared LED has a peak emission wavelength of 950nm.

The diode voltage found to give a current of $I_D = 14mA$:

$$V_D = 1.1817V$$

After adding a resistor $R1 = 560Ohms$ in series with the IR LED:
By KVL:

$$V_s = V_D + V_R = V_D + I_R * R$$

After the diode is turned on:

$$V_D = V_{TurnOn}$$

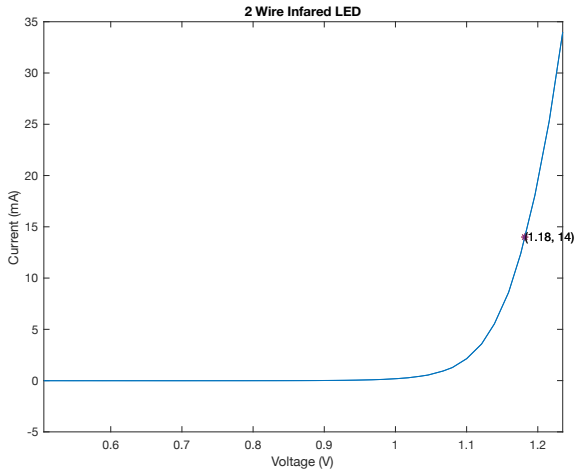
$$V_s = 1.2 + 14mA * 560 \approx 9V$$

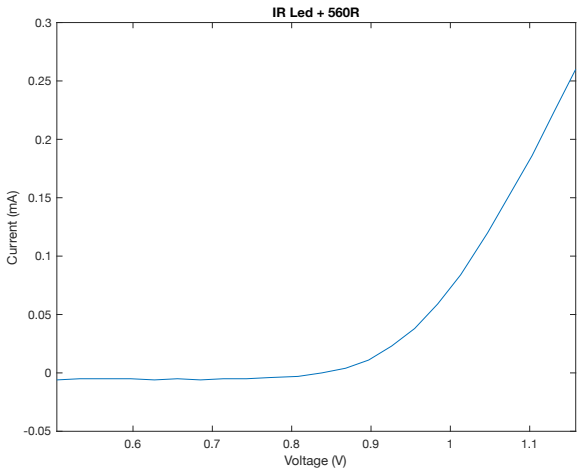
Sweep Voltage upper limit:
The output observed is linear as after the LED turns on, the LED acts as an on diode, and therefore acts like a short circuit allowing current to flow.
For $I_D = 5mA$:

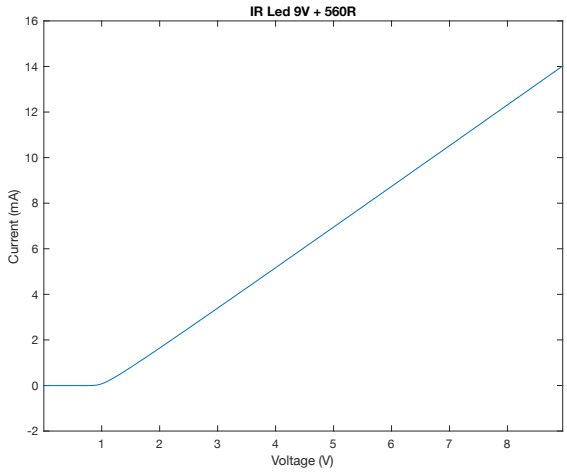
$$V_D = 3.931V$$

For $I_D = 10mA$:

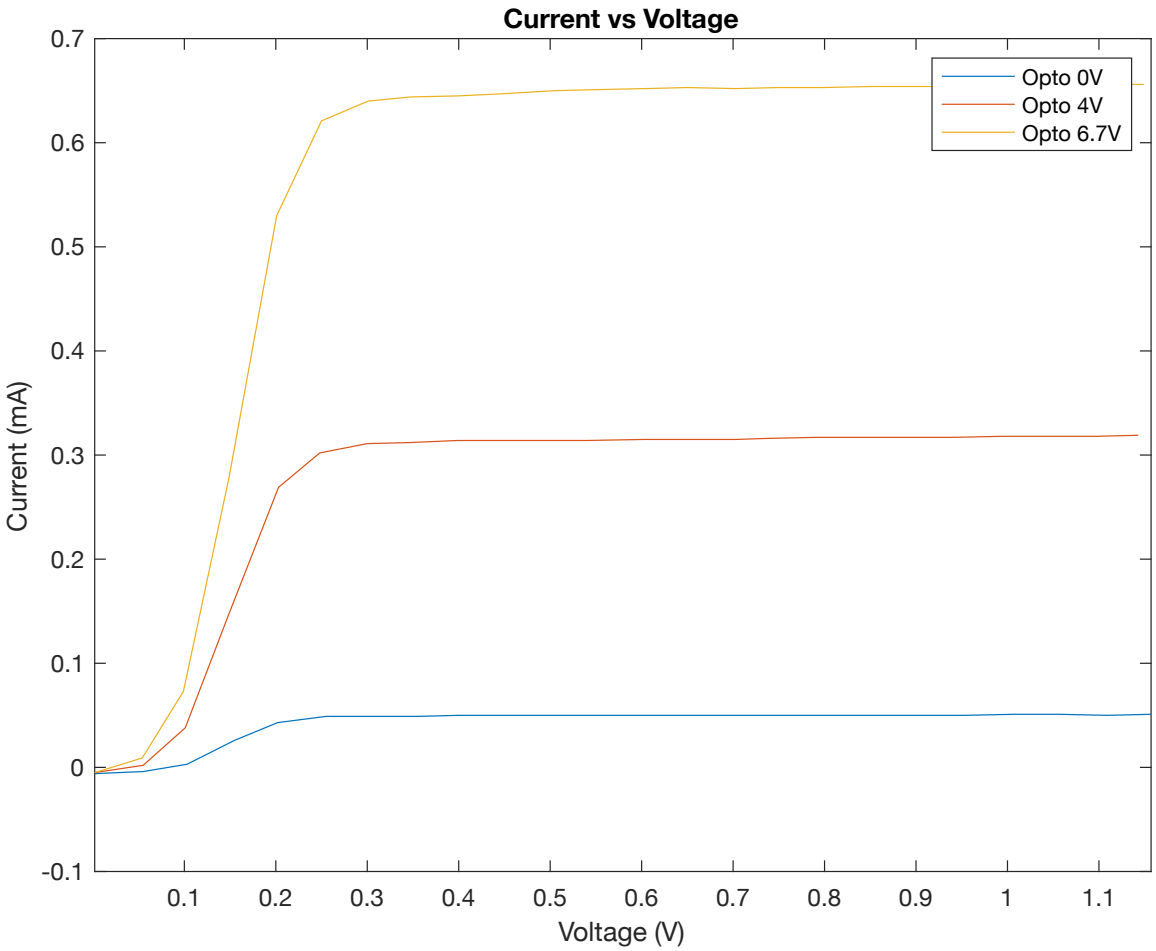
$$V_D = 6.718V$$







Part 2



The beta ratio is as follows:

$$\beta = \frac{I_C}{I_D}$$

As the base current is dependent on the current produced by the diode (IR LED).

For $I_D = 5mA$:

$$I_C = 0.3163mA$$

Therefore the Beta ratio:

$$\beta = \frac{0.3163}{5} = 0.06326$$

For $I_D = 10mA$:

$$I_C = 0.6530mA$$

Therefore the Beta ratio:

$$\beta = \frac{0.6530}{10} = 0.0653$$

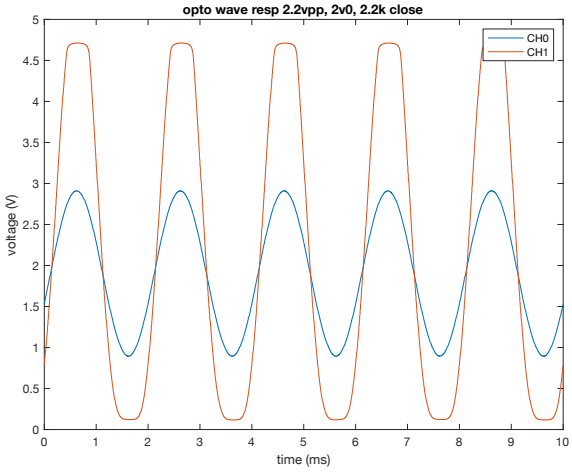
Part 3
Using the following components:
$R1 = 560Ohms$, $R2 = 4.7kOhms$, $V_{cc} = 5V$
With the FGEN set to $V = 1.2V$

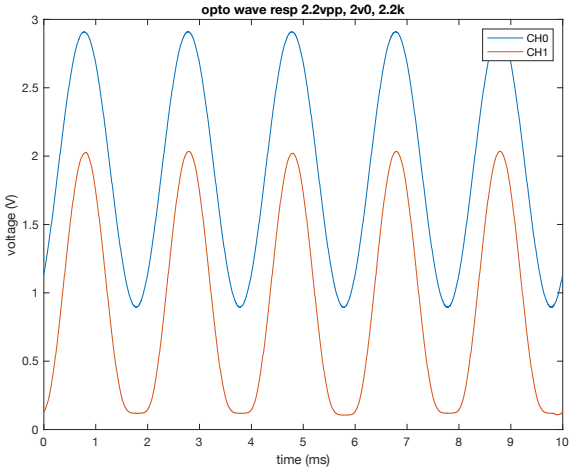
When Changing $R2$ from $4.7kOhms$ to $2.2kOhms$ the amplitude of the receiver voltage was reduced linearly.

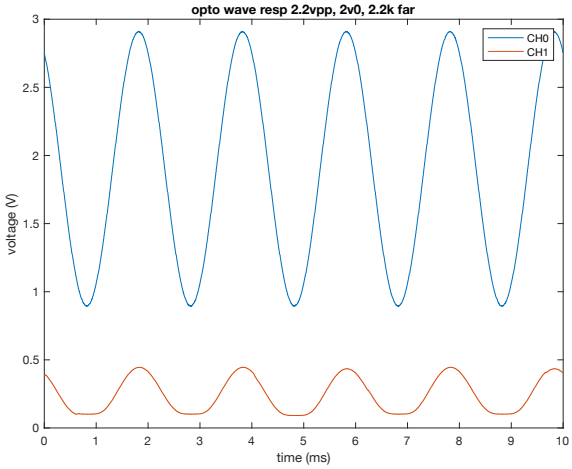
To improve the linear range of the output, you can increase the amplitude of the function generator or decrease the distance between the transmitter and receiver.

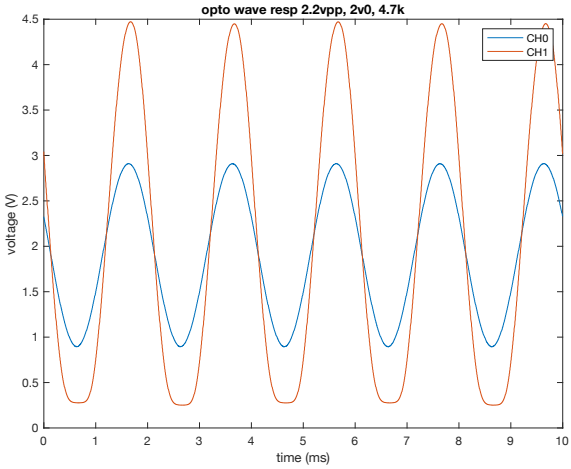
Tests were conduced with a piece of paper between the transmitter and receiver, the transmitter and receiver being closer together and moving them far apart. Certain settings provided an undistorted output signal as the signal lied in the forward active region.

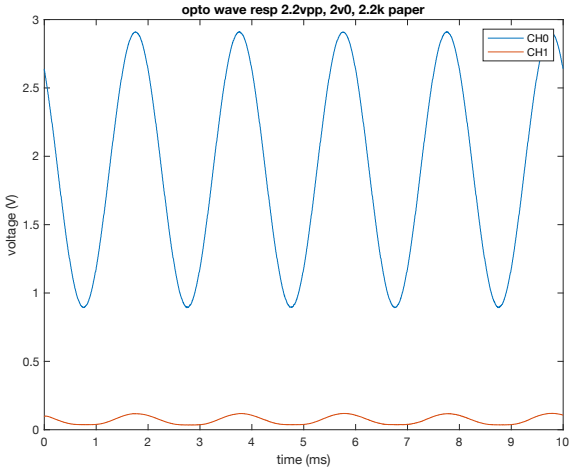
The IR communication link employs the small-signal operation as the input signal is very small as required for small-signal models. The resistors are incorporated to ignore the current across the LED and observe a linear voltage as in part 1. The factors affecting optical communication could include the function generator amplitude (input voltage), space between the transmitter and receiver, and external light affecting the signal. Using the bench function generator, the same output was recorded.

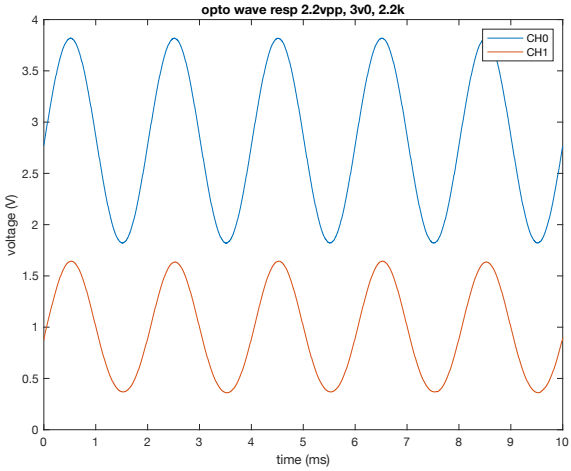

opto wave resp 2.2vpp, 2v0, 2.2k close
CH0
CH1
voltage (V)
time (ms)

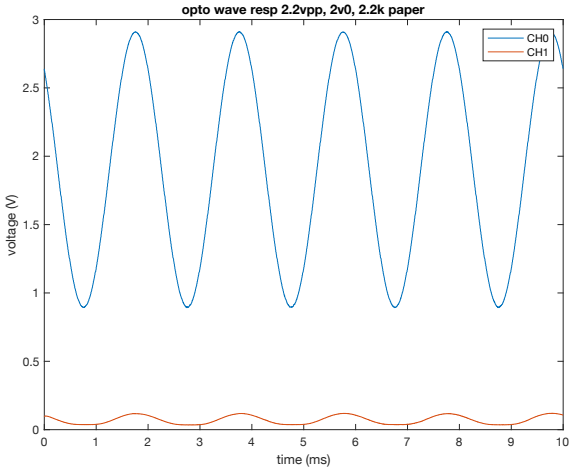

opto wave resp 2.2vpp, 2v0, 2.2k
CH0
CH1
voltage (V)
time (ms)


opto wave resp 2.2vpp, 2v0, 2.2k far
CH0
CH1
voltage (V)
time (ms)


opto wave resp 2.2vpp, 2v0, 4.7k
CH0
CH1
voltage (V)
time (ms)


opto wave resp 2.2vpp, 2v0, 2.2k paper
CH0
CH1
voltage (V)
time (ms)


opto wave resp 2.2vpp, 3v0, 2.2k
CH0
CH1
voltage (V)
time (ms)


opto wave resp 2.2vpp, 2v0, 2.2k paper
CH0
CH1
voltage (V)
time (ms)