OPTICAL RECEIVER KVSFLQD##

TYPICAL PHOTODIODE WILL OUTPUT ≈ 2NA OF CURRENT AT MAX LIGHT (ASSUMED FROM GENERAL RESEARCH). I'LL USE A TRANS IMPEDANCE AMPLIFIER TO AMPLIFY THE RECEIVED CURRENT WAVEFORM INTO A VOLTAGE WAVEFORM.

I'LL HAVE A +5V RAIL, THIS CIRCUIT DRIVES INTO A HEADPHONE AMP. TARGET V_O IS 1V. THE TRANSMITTER IS OUTPUTTING A 4 KHZ BANDWIDTH.

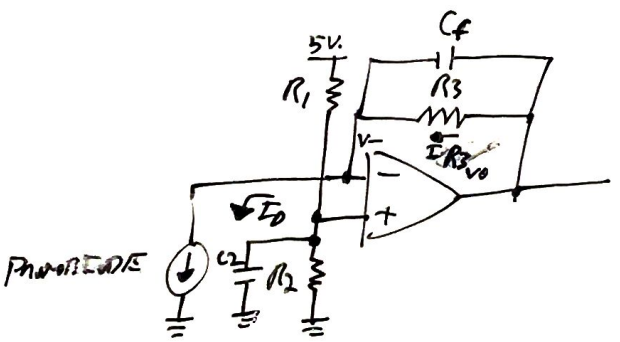
SPEC'S

$I_{in} = 0.5 - 2NA$ → 0.5NA CHOSEN ARBITRARILY FOR ENG. JUDGEMENT AS LOWEST SIGNAL

$V_{OUT} = 1V_{p-p}$, $1V_{OFFSET}$ → AN OFFSET OF 1V ALLOWS FOR AUDIO SIGNALS TO NOT SATURATE NEGATIVE RAIL USING SINGLE SUPPLY.

$B_W = 4KHZ$

$V_{cc} = 5V$



1) SET R_3 TO OUTPUT $\frac{1V_{p-p}}{2} = 500mV$ AT MAX INPUT PHOTODIODE CURRENT. WITH A 1V OFFSET THIS IS 1.5V MAX

$I_{R3} = I_D$

$V_{R3} = \frac{V_O - V_-}{I_{DMAX}} = \frac{1.5V - 1V}{2NA} = \frac{0.5V}{2NA} = \boxed{250K\Omega} = 249K\Omega$

I WANT TO MAKE THIS VARIABLE BETWEEN 500nA & 2NA

$V_{R3} = \frac{V_O - V_-}{I_{DMIN}} = \frac{1.5V - 1V}{500nA} = \boxed{1MEG\Omega}$

2) Set Feedback capacitor for band width. C_f and R_3 are a simple RC low pass filter. Set at R_3 max

$$C_{f(1meg)} \frac{1}{2\pi \cdot R_3 \cdot f_{BW}} = \frac{1}{2\pi \cdot 1MEG \cdot 4KHZ} = \boxed{39.8\ pF}$$

↳ use 33 pF std value

↳ $\boxed{f_{BW(33pF)} = 4.82\ KHZ}$

$C_{f(250K)} = \boxed{159.1\ PF}$

use 33 pF so that f_{BW} is minimum at highest gain.

$$f_{BW}(C_f = 33PF) = \frac{1}{2\pi (250K\Omega)(33PF)} = \boxed{19.29\ KHZ}$$

3) Calculate op-amp GBW. (using TI SBOA220a)

$$GBW > \frac{C_i + C_f}{2\pi R_1 C_f^2}$$

$C_i = (C_j + C_d + C_{cm})$

C_j = C photo diode junction

C_d = op-amp diff capacitance

C_{cm} = op-amp common mode capacitance

I'm using the OPA322 as described in app note. It works fine for me, open to improvements later.

$C_d = 5PF$

$C_{cm} = 4PF$

Photo diode is ~~WÜRTH 154005-1 EA3590~~ ON SEMI QSD2030

$C_j = 15PF$

$C_i = 15PF + 5PF + 4PF = 24PF$

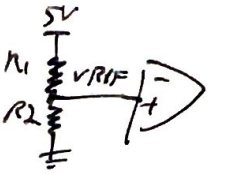
$GBW(R_3 = 250K) = 33.3\ KHZ$

$GBW(R_3 = 1MEG) = 8.33\ KHZ$

I'm not sure this is actually correct, equation assumes fixed f_{BW}. OPA322 = 20mHZ... moving on..

4) CALCULATE V_{REF} RESISTOR BIAS = 1V.

$V_{REF} = 1V$



$$V_{REF} = \frac{R2}{R1+R2} \cdot 5V$$

$$(R1+R2)V_{REF} = R2 \cdot 5V$$

$$\left(\frac{R1}{R2}+1\right) V_{REF} = 5V$$

$$R1 + R2 = \frac{5V}{V_{REF}} R2$$

$$R1 = \left(\frac{5V}{V_{REF}} - 1\right) R2$$

Assume $R2 = 10K\Omega$

$R1 = 40K\Omega$

$R1 = 40.2K\Omega$

$R2 = 10K\Omega$

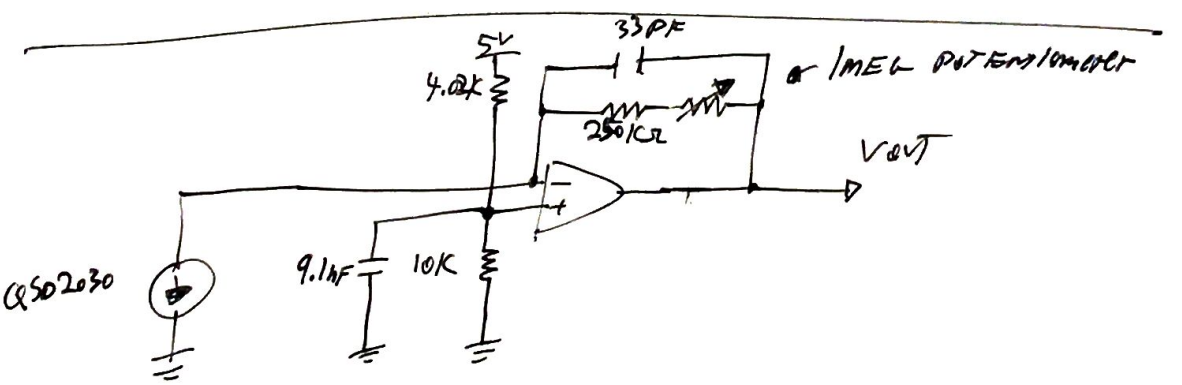
$R1 = 4.02K\Omega$

$R2 = 1K\Omega$

5) Calculate C2 @ (9.1 nF) for VALUE

$$f_{POLE} = \frac{1}{2\pi \cdot C_2 \cdot (R_1 \parallel R_2)} = 21.84\ KHz$$

THIS IS A LPF FOR V_{REF}



$NF_{TOTAL} = 1.25$ MEG POSSIBLE $= f_{BW} 3.85$ KHZ