EE330 Lab 10
Section 5, 8:00 am

Discrete Semiconductor Amplifiers

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Part 1: BJT Parameter Extraction

Small signal parameters given for PN2222 transistor at I_C = 1.0 mAdc, V_{CE} = 10 Vdc:

$\beta = 50 \Leftrightarrow 300$ $g_\pi = 2.0\ k\Omega$ $g_0 = 5.0$ uMhos $g_m = 50*2 = 100$

Early voltage measured from parameter analyzer:
$V_{AF} = -185.195$

Circuit Calculations:
With $\beta = 195$, I_B must be small for I_C = 1 mA $\Rightarrow$ I_B = 1 mA / 195 = 5.13 uA
Then, R_1 = (10+5-.6) V / 5,13 uA = 2.8 mΩ
(Will be using 2 x 1 mΩ, 680 kΩ, 150 kΩ in series to build resistor
Picking V_O = 3.3V, then R_F = 3.3 kΩ

Circuit Measurements:
R_1 = 1.974 mΩ
$I_C = V_O/R_F$ = 3.284 V / 3.3k = .995 mA
I_B = 10 V / R_1 = 5.167 uA

Calculated Parameters:
β calculated using parameter analyzer measurements:
β = 1.95 mA / 10 uA = 195
$g_m = I_C/V_T$ = .995 mA / .026 V = 38 m
$g_\pi = g_m/\beta$ = 1.58 / 195 = 196 m
$g_0 = I_C/V_A$ = 5.37 uMhos

Comparisons:

β, at 195, is nicely within the given range (50 - 300).
g_0, at 5.37 uMhos is also fairly close to the given 5.0 uMhos
g_m however, at 38 m, is nowhere near the calculated 100
g_π, dependant on g_m, is also very far: 196 m $\Leftrightarrow$ 2 k

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Index	Ibase	Vcollector	Icollector	Isubs	Vbase
90	10.0000 uA	4.4500 V	1.94556 mA	15.847 pA	647.384 mV
91	10.0000 uA	4.5000 V	1.94588 mA	-23.921 pA	647.372 mV
92	10.0000 uA	4.5500 V	1.94648 mA	-6.822 pA	647.358 mV
93	10.0000 uA	4.6000 V	1.94690 mA	-10.184 pA	647.338 mV
94	10.0000 uA	4.6500 V	1.94728 mA	-159.033 pA	647.330 mV
95	10.0000 uA	4.7000 V	1.94757 mA	-134.405 pA	647.332 mV
96	10.0000 uA	4.7500 V	1.94772 mA	-76.274 pA	647.330 mV
97	10.0000 uA	4.8000 V	1.94786 mA	-61.090 pA	647.350 mV
98	10.0000 uA	4.8500 V	1.94816 mA	-35.755 pA	647.358 mV
99	10.0000 uA	4.9000 V	1.94838 mA	-23.902 pA	647.368 mV
100	10.0000 uA	4.9500 V	1.94864 mA	-19.156 pA	647.370 mV
101	10.0000 uA	5.0000 V	1.94883 mA	-18.744 pA	647.384 mV
102	12.000 uA	0 V	-11.9271 uA	-20.149 pA	529.210 mV
103	12.000 uA	50.0 mV	100.2326 uA	-14.291 pA	578.024 mV
104	12.000 uA	100.0 mV	642.547 uA	-8.421 pA	620.170 mV
105	12.000 uA	150.0 mV	1.66775 mA	-6.270 pA	644.526 mV
106	12.000 uA	200.0 mV	2.17465 mA	-5.593 pA	651.544 mV
107	12.000 uA	250.0 mV	2.27715 mA	-6.125 pA	652.784 mV
108	12.000 uA	300.0 mV	2.29375 mA	-4.495 pA	652.982 mV
109	12.000 uA	350.0 mV	2.29720 mA	-3.436 pA	653.024 mV
110	12.000 uA	400.0 mV	2.29855 mA	-3.928 pA	653.052 mV
111	12.000 uA	450.0 mV	2.29962 mA	-3.233 pA	653.060 mV
112	12.000 uA	500.0 mV	2.30052 mA	-3.393 pA	653.074 mV
113	12.000 uA	550.0 mV	2.30141 mA	-1.523 pA	653.088 mV

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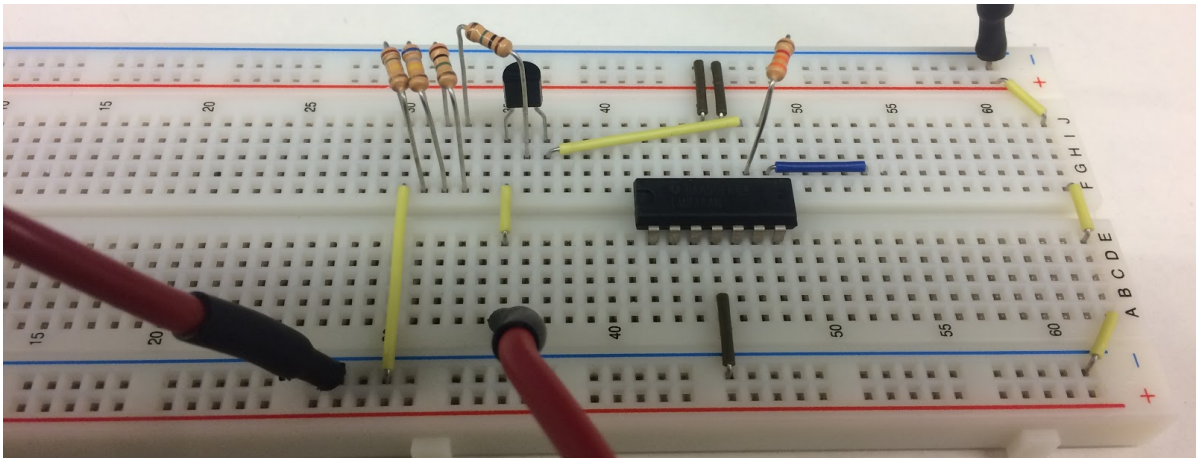
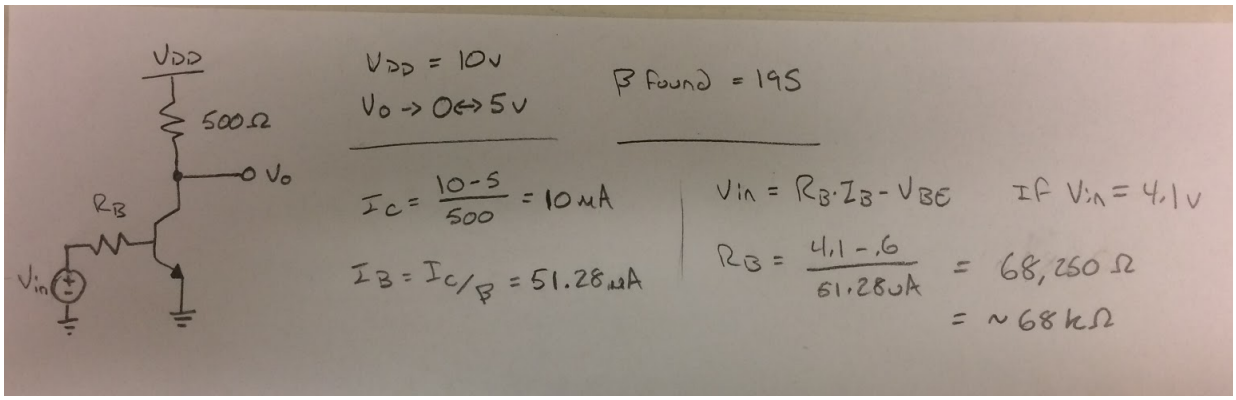
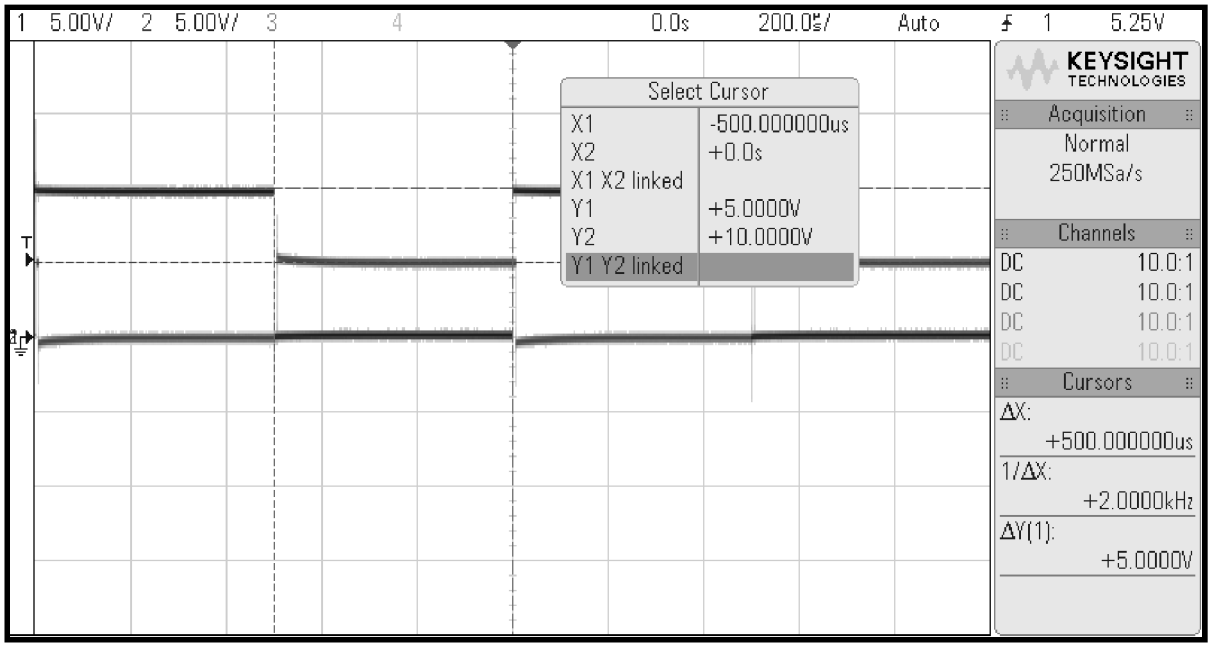
Section of output from the parameter analyzer



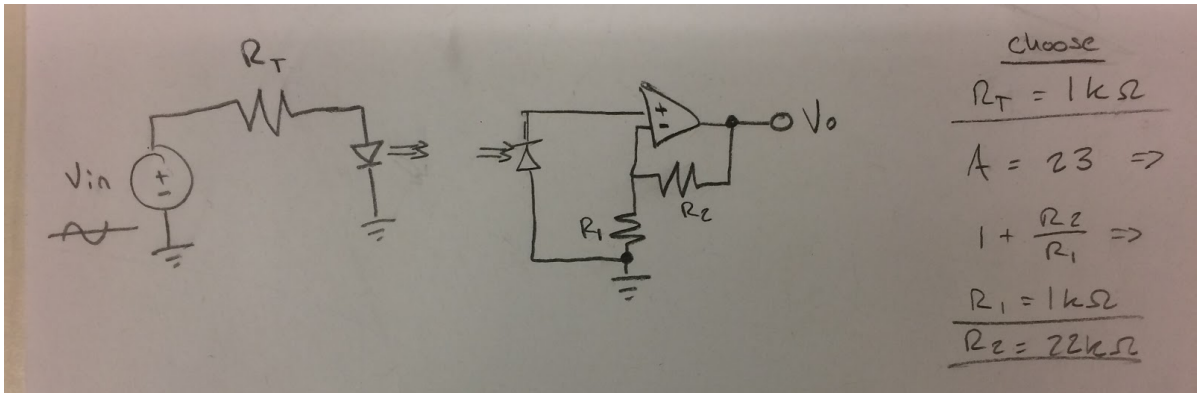
Part 2: Boolean Signal Circuit





Part 3: Wireless Optical Link

The audio signal will be transmitted using a photodiode, and the received signal will be amplified using an LM324 op-amp, then directed to the speaker:



The output would then be hooked up to a unity gain amplifier.
R_T was set to 1k ~arbitrarily so the diode didn't burn out.