



Musical Instrument: Electronically Resonated Metal

ECE 445

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Professor Singer
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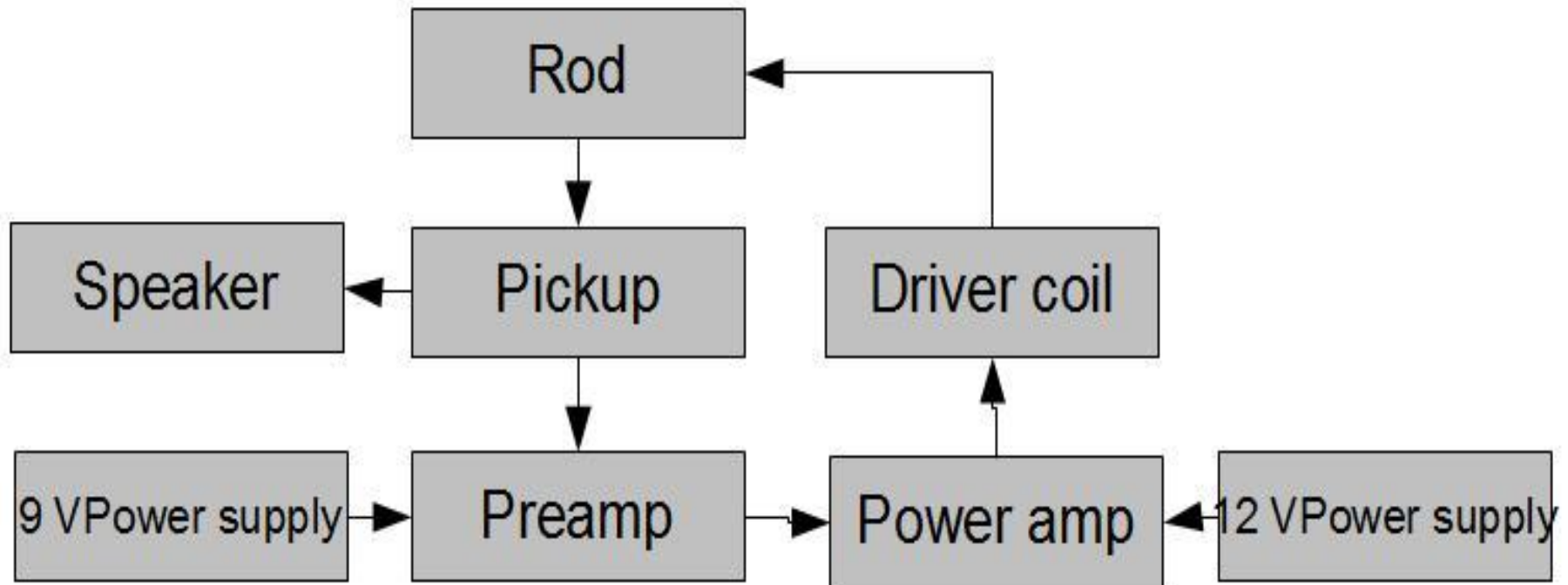
Introduction

- A new musical instrument
 - Produces a unique sound
 - Easy to learn and play

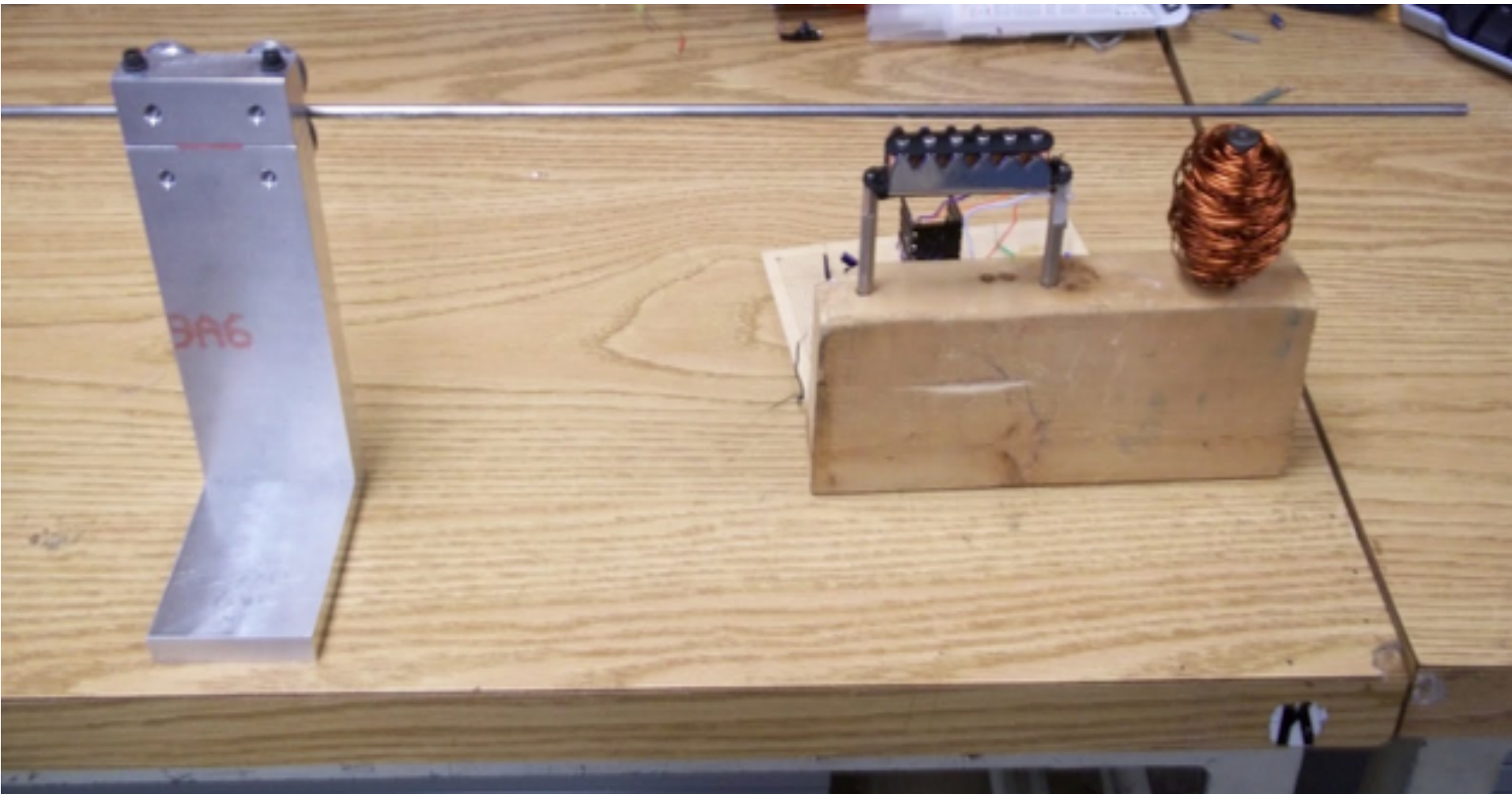
Objectives

- High output current from amplifier
- Sustain vibrations in the rod

Block Diagram



Instrument Layout



Rod

- magnetic
- frequencies given by:

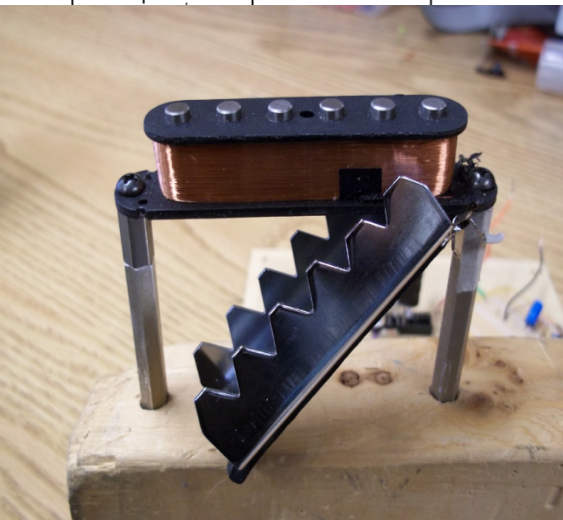
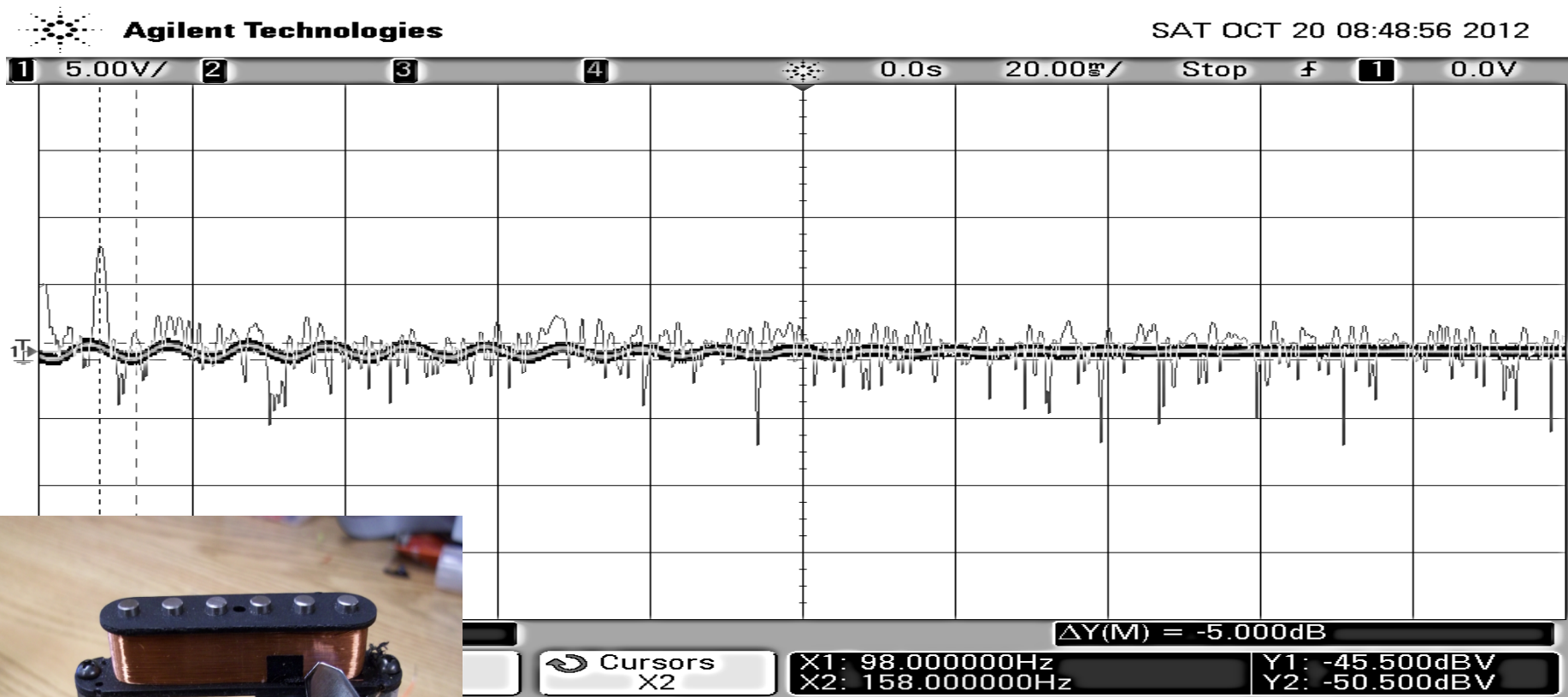
$$f = (1.194^2, 2.988^2, 5^2, 7^2) \frac{\pi \kappa \epsilon}{8L^2}$$

Requirements and Verification Testing:

shortest: 19 cm  78, 488, 1368, 2682 Hz

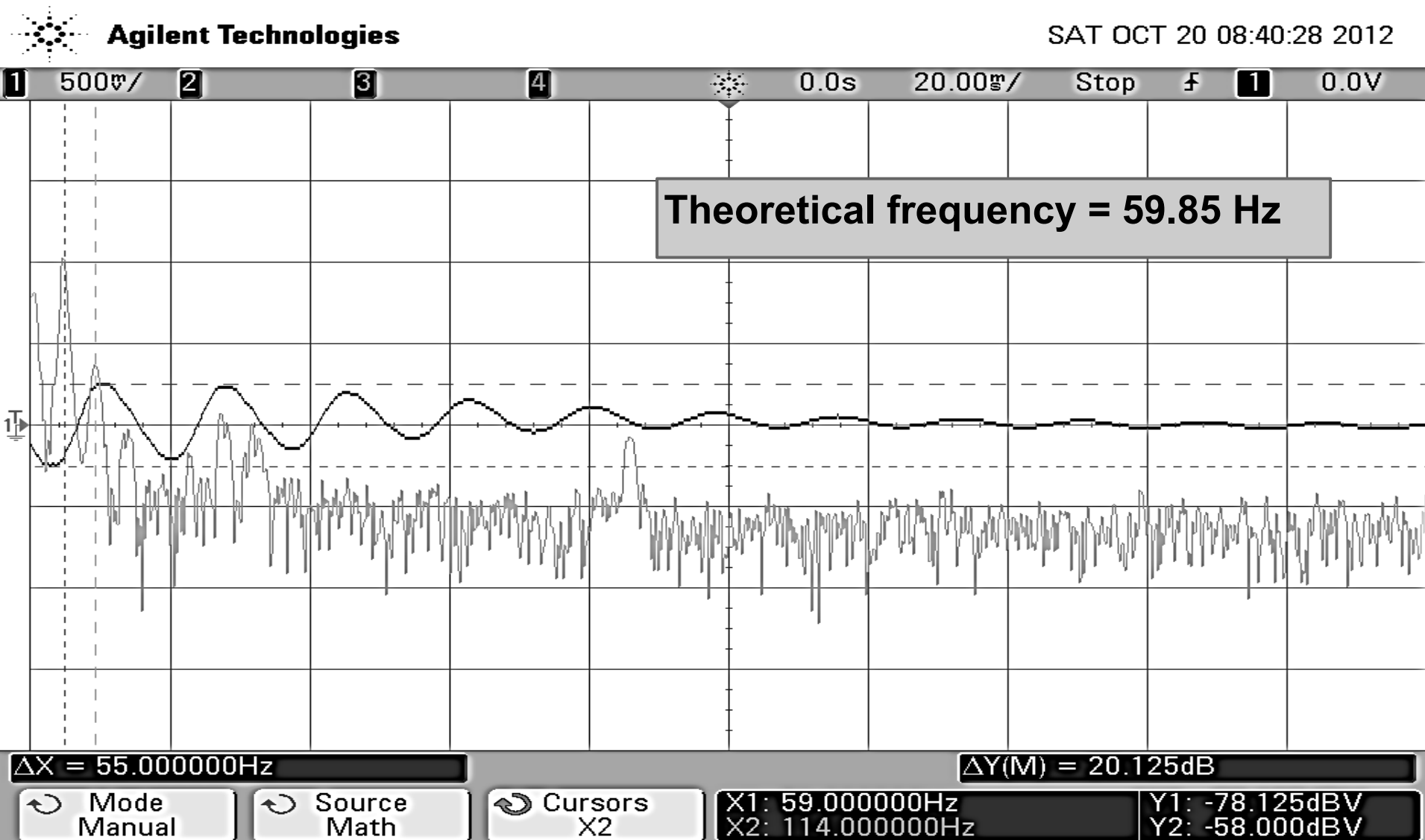
longest: 90 cm  3.478, 21.78, 61, 119.5 Hz

Pickup Coil

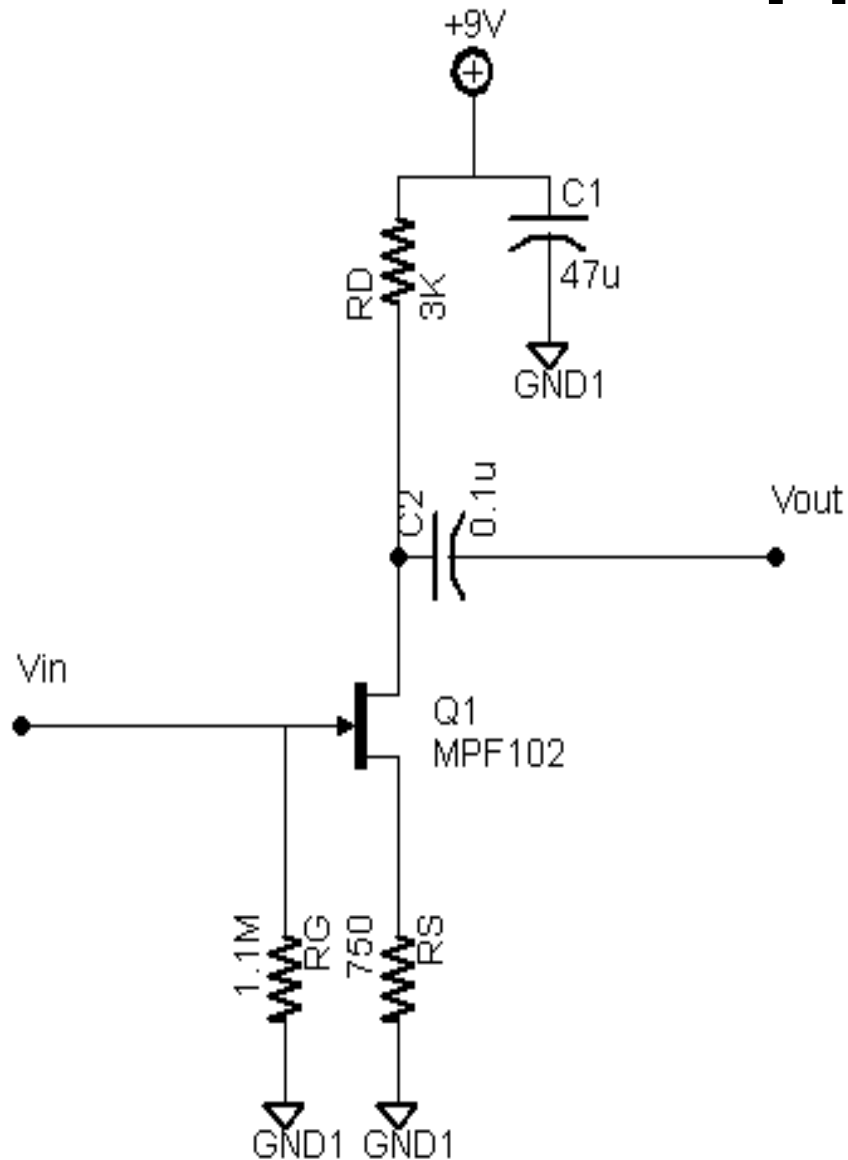


Theoretical frequency = 97.89 Hz

Pickup Coil



Preamp



- Common Source with Source Degeneration
- Transconductance: $2000\mu S < G_m < 7500\mu S$

Preamp: Requirements and Verification

Common Source with Source Degeneration Amplifier:

$$\text{Midband Gain} = -gm \frac{RD || RL}{1 + gmRs}$$

Requirement:

Preamp must amplify the signal at least 1.2 V/V

Verification:

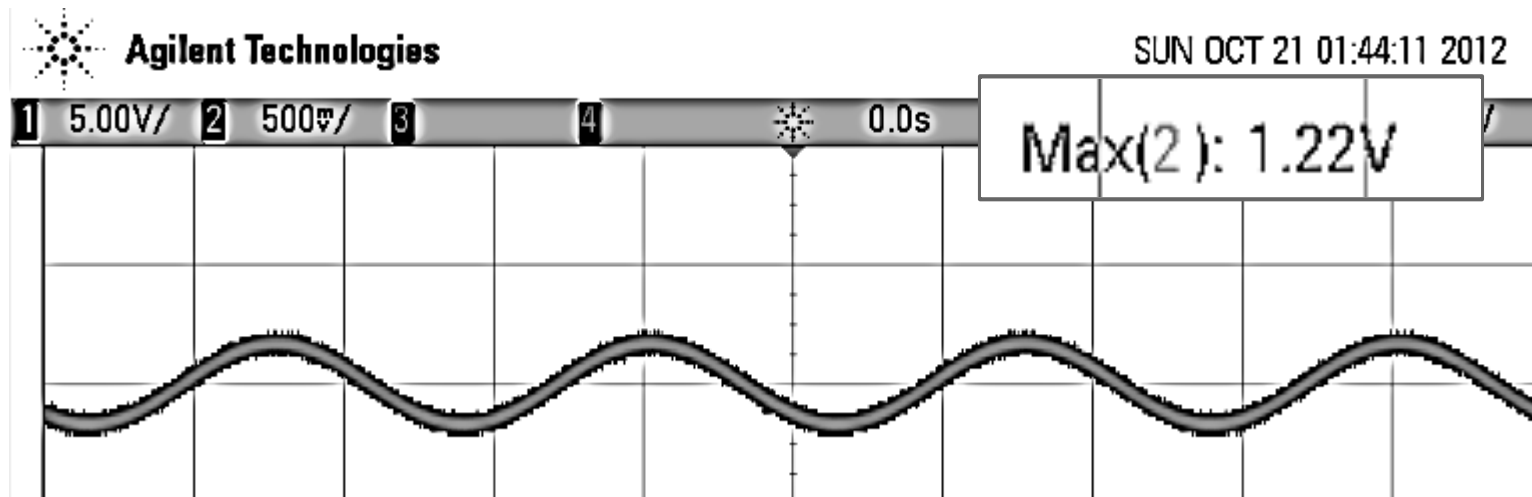
Vin from signal generator

Display Vout on the Oscilloscope

Calculate Midband Gain

Results: Test Passed

Preamp: Results



Input Voltage: 1V p-p
Frequency 39.4 Hz

Output Voltage: 1.22 V p-p
Frequency 39.4 Hz

Mid Band Gain: 1.22 V/V

Preamp: Performance Testing

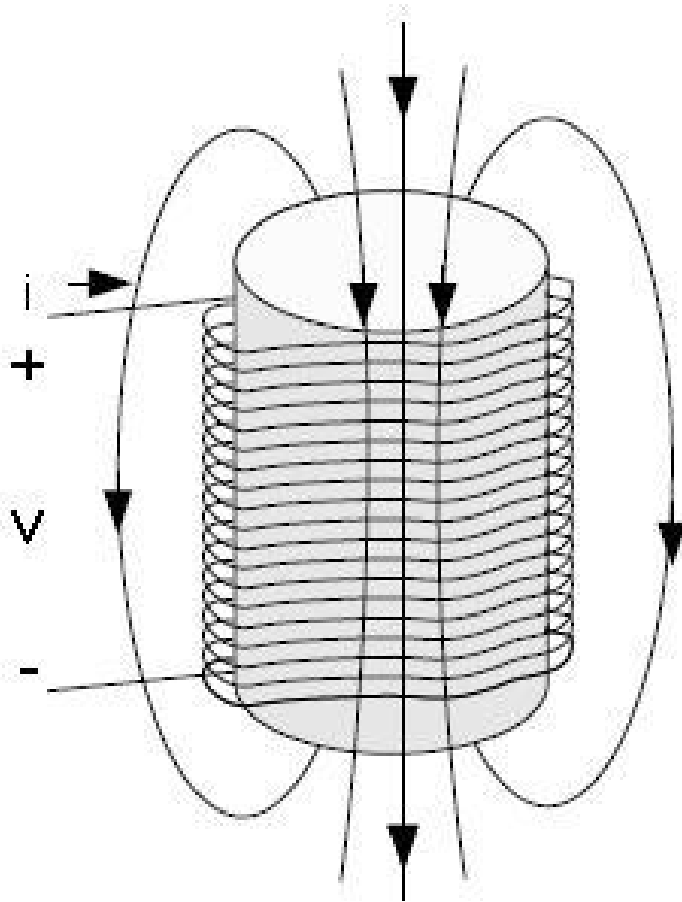
Room Temperature by Location	MidBand Gain of Preamp
Very Warm (> 25 degree Celsius)	1.5 V/V
~25 degrees Celsius	2.5 V/V
Chilly (< 25 degrees Celsius)	3.3 V/V

Results:

No Consistency in Mid Band Gain for the pre-amp

Why?

Driver Coil



$$\mu_{iron} = 125 H/m$$

$$N = \frac{Bl}{i\mu_o\mu_{iron}}$$

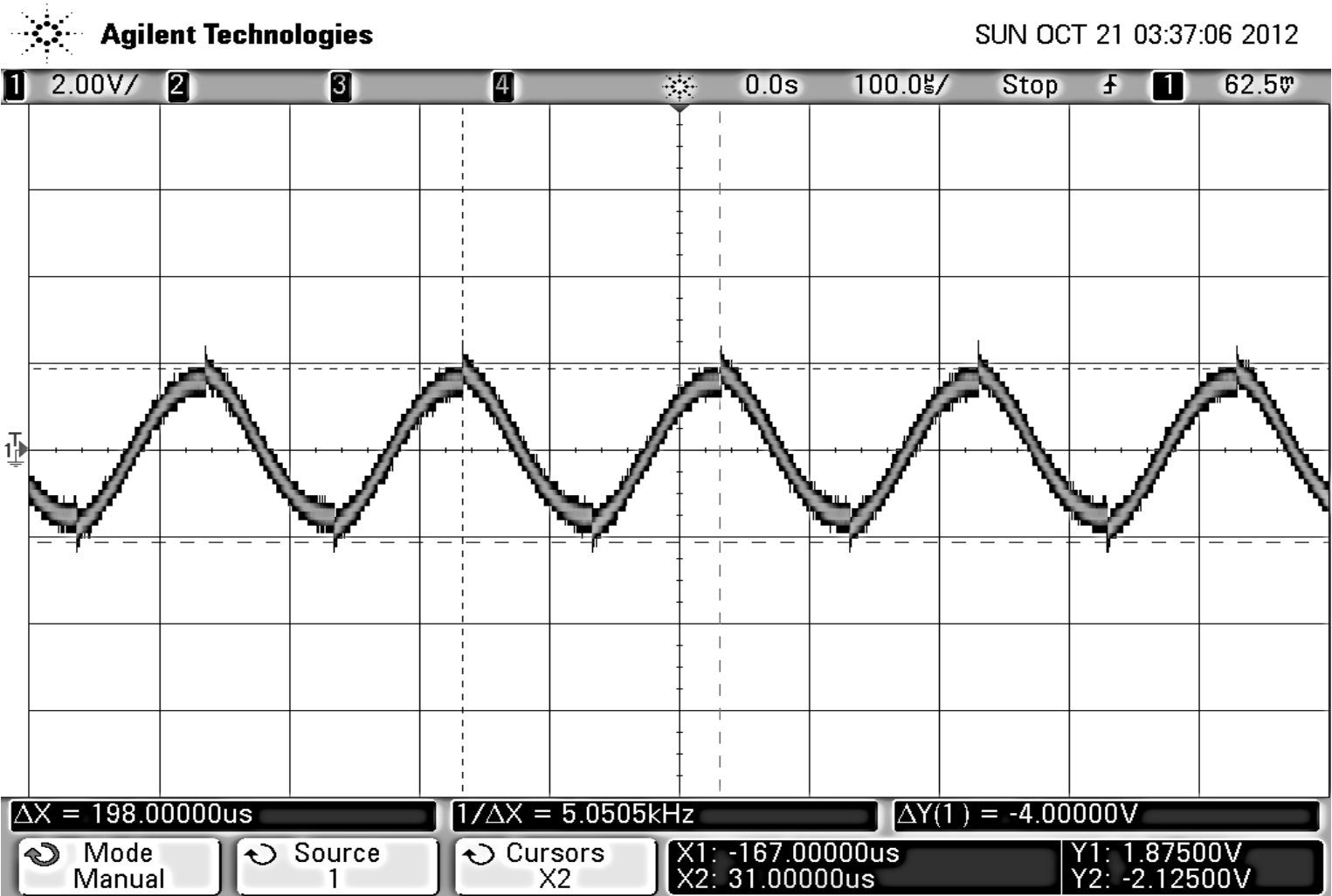
Max Magnetic Field $B = 1.6 \text{ T}$

Length $l = 4 \text{ cm}$

Current $i = 7 \text{ A}$

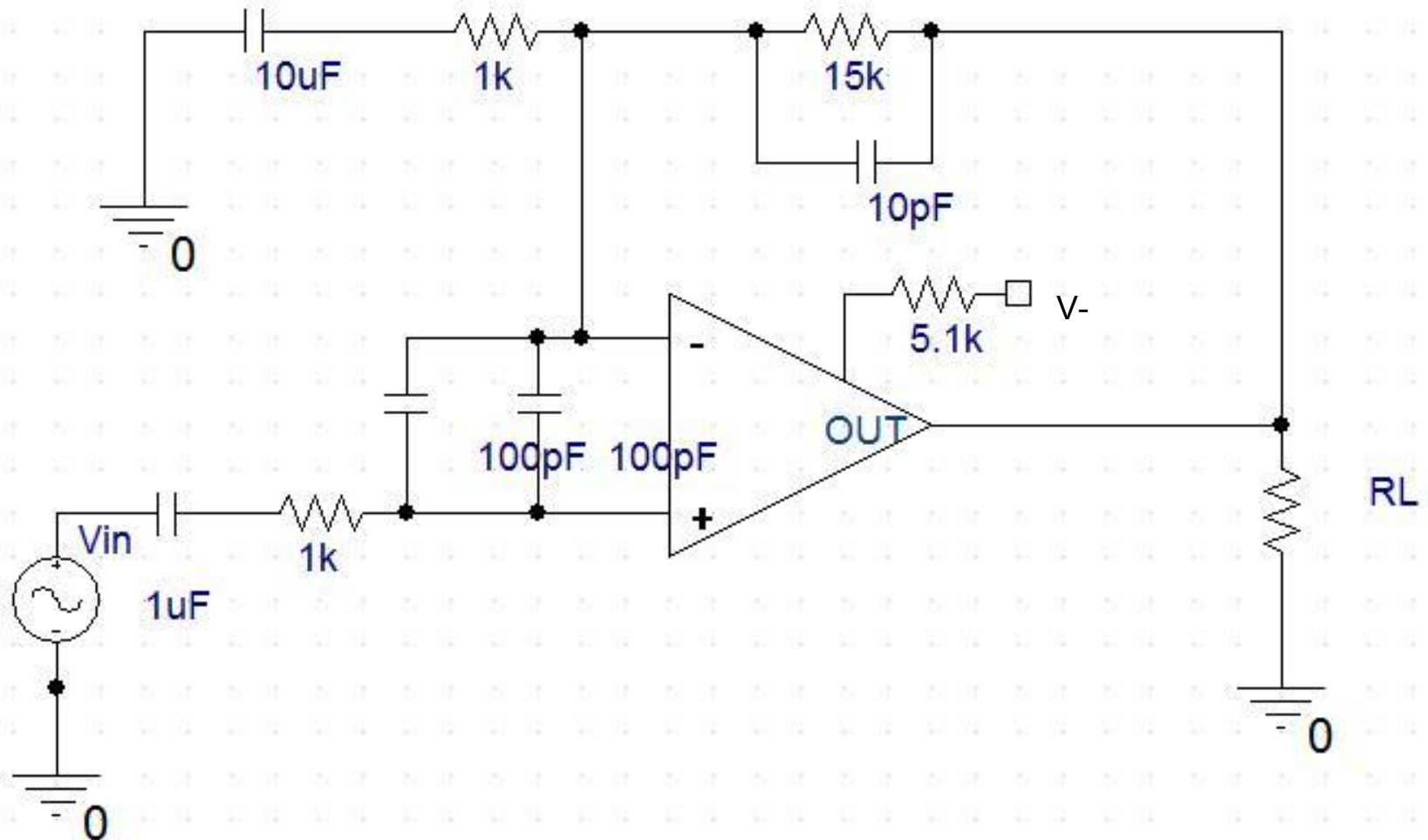
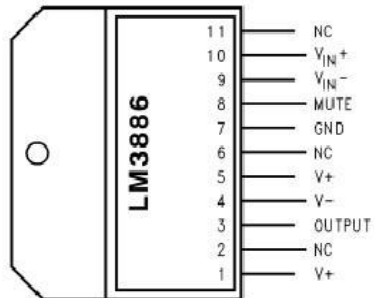
Min Number of Turns $N = 58.2$

Driver Coil



function generator set to 5.02 kHz

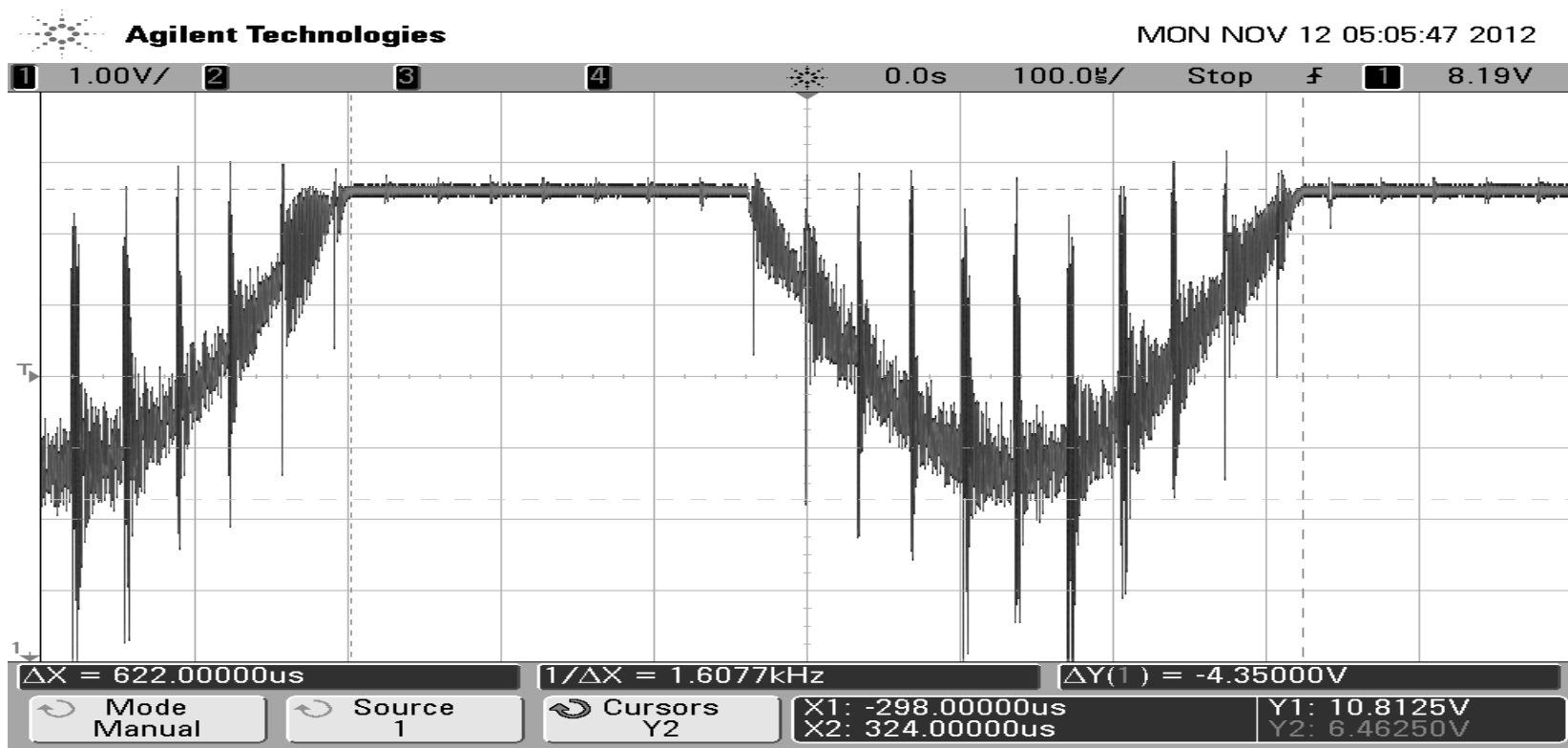
Power Amplifier



Power Amplifier

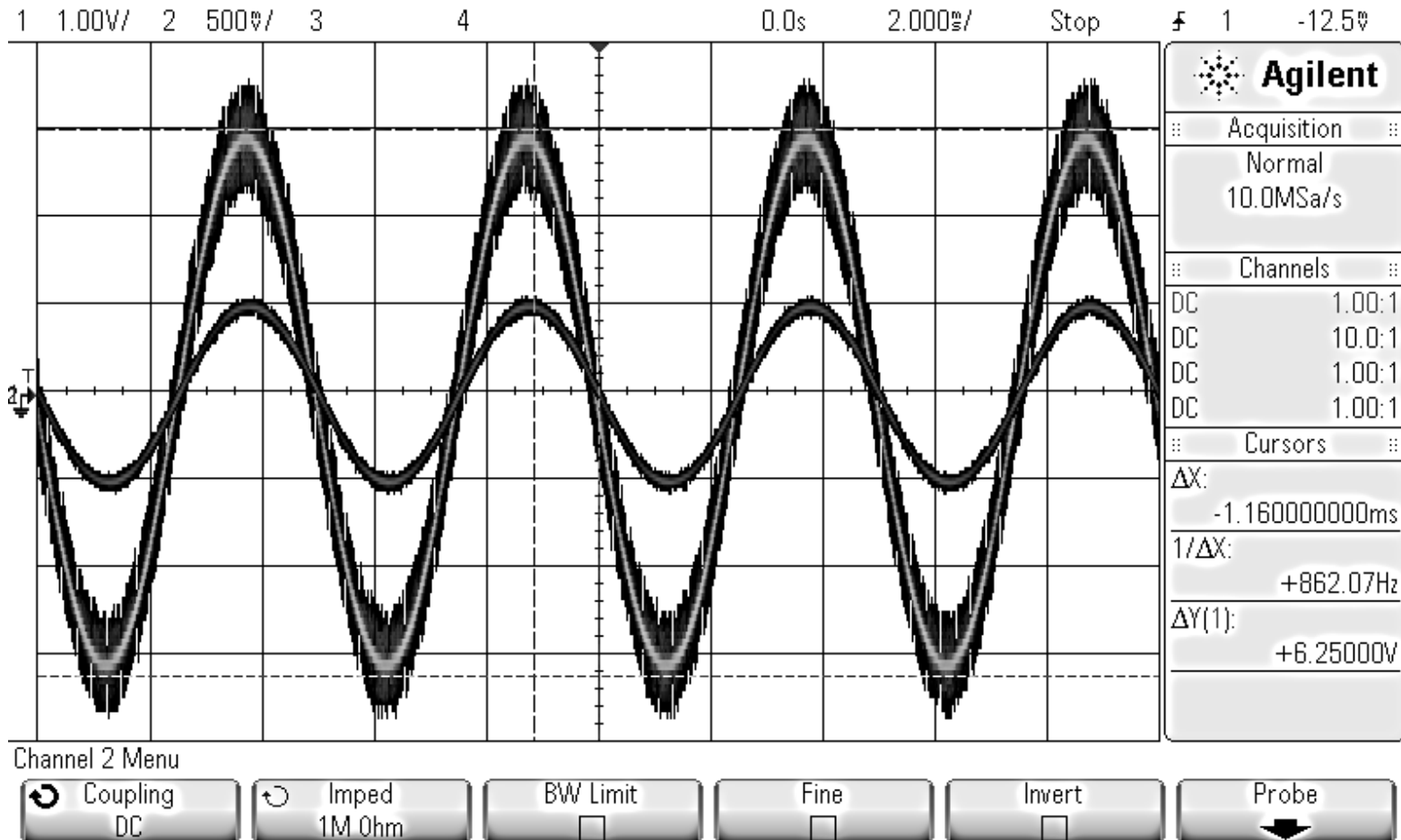
Problems encountered:

- overheating
- voltage clipping at output
- noisy



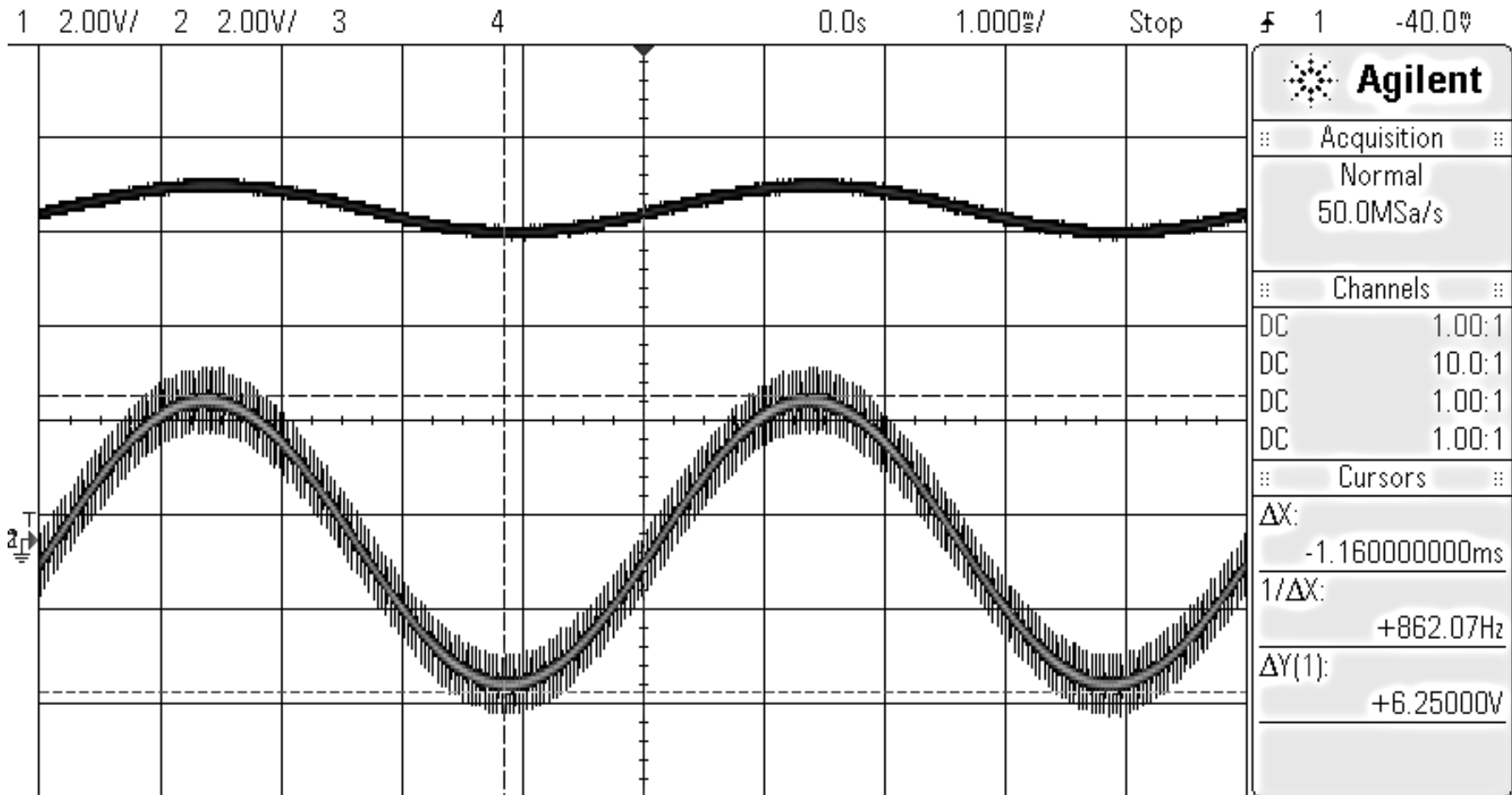
Power Amplifier

DSO-X 3034A, MY52103462: Thu Nov 29 04:36:42 2012



Power Amplifier

DSO-X 3034A, MY52103462: Thu Nov 29 04:41:39 2012



Cursors Menu

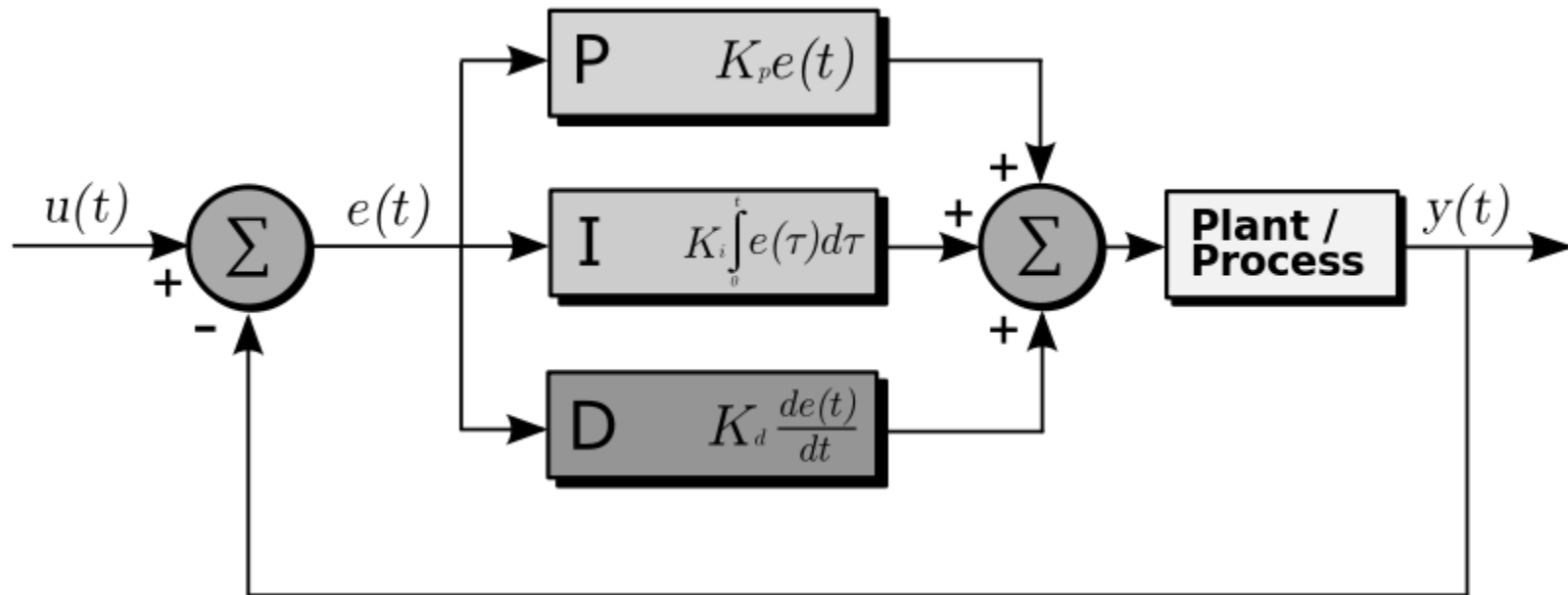
Mode Manual	Source 1	Cursors Y1	Units ↓	X1: 0.0s X2: -1.160000000ms	Y1: -3.22500V Y2: 3.02500V
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Ethical Issues

- Safety
 - high current output
- Consistency

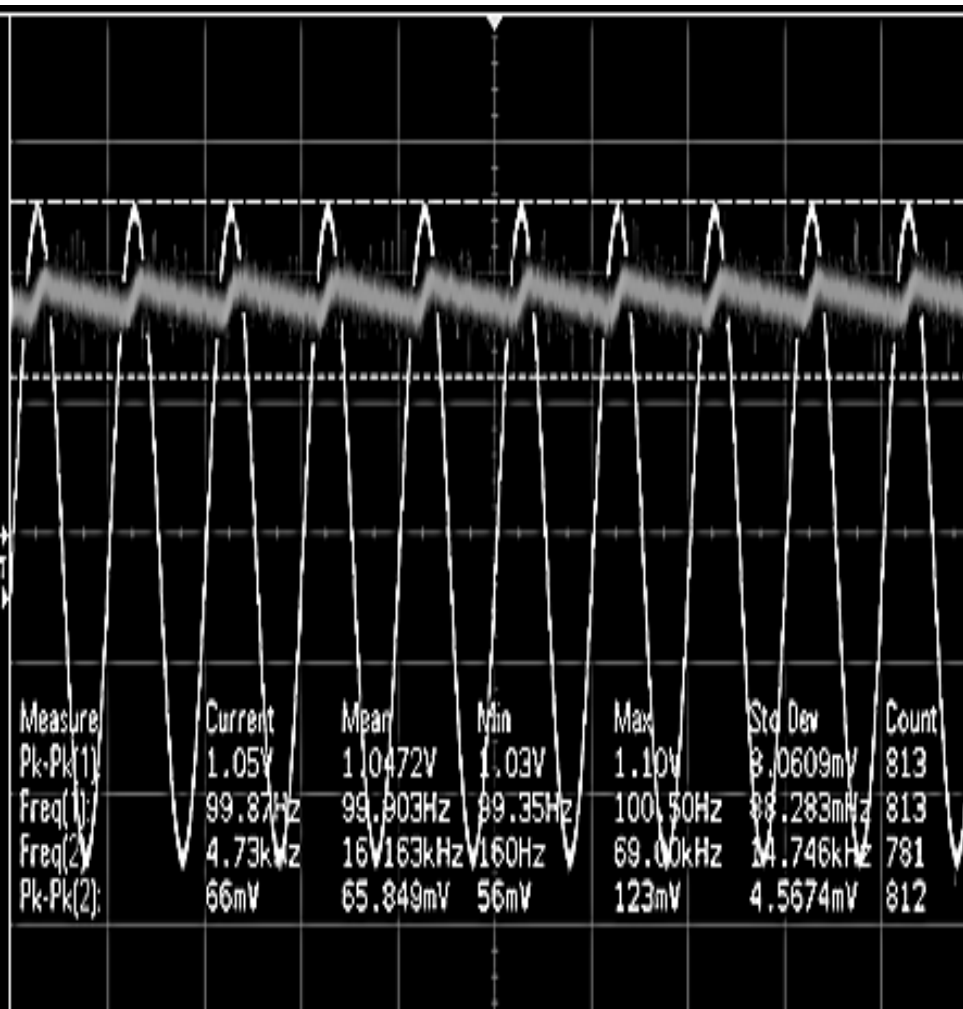
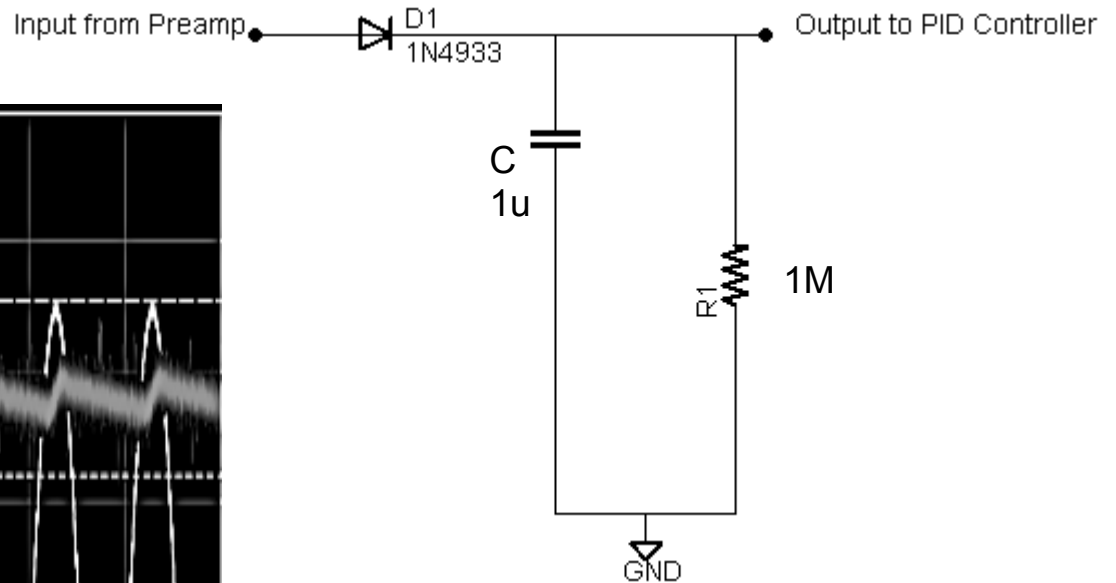
Recommendations for Further Work

- High pass filters
- PID controller



Source of the Image: http://upload.wikimedia.org/wikipedia/commons/4/43/PID_en.svg

Other Tests(Peak Detector)





Questions?