EE254

Project 2

10/22/13

Experiments with Standard Power Amplifiers

Three classes of power amplifiers, class 'A', class 'B', and class 'AB' were designed and built using the available complimentary npn/pnp TIP31 transistors used in order to deliver a large amount of power. All three power amplifier circuits obtained an input signa was designed as shown in the Design and calculation op-amp was to amplify the input signal from the signal g ntire signal at the output side of the power amplifiers.

Class 'AB' Power Amplifier

The design of this class of power amplifier is shown in the Design and calculation section. A 100uF capacitor was connected to the input side of the driver circuit to allow only the AC signal from the op-amp to be fed to the driver circuit. As shown in the results and plots section (Figure 1 and 2), measurements of the signal gain were measured at every stage to ensure no significant attenuation. During the experiment, the power transistors experienced thermal runaway and the problem was solved by connecting emitter resistors (RE) on each transistor. A lower RE resistor value was selected to avoid high attenuation of the signal. Vcc was increased when distortion was observed and the ou 3). Icq, Vrms, and Vcc v of the power amplifier a was obtained and P_{Load}

Class 'B' Power Amplifier

The power transistor base terminals were both connected to the output of the op-amp stage as shown in the designed and calculation section. Output waveform was obtained as shown in figure 4. As expected, distortion was observed and total harmonic distortion calculated using the frequency domain waveform (Figure 5) obtained from running FFT of the output waveform. The total and design sectio % was obtained and P

Class 'A' Power Amplifier

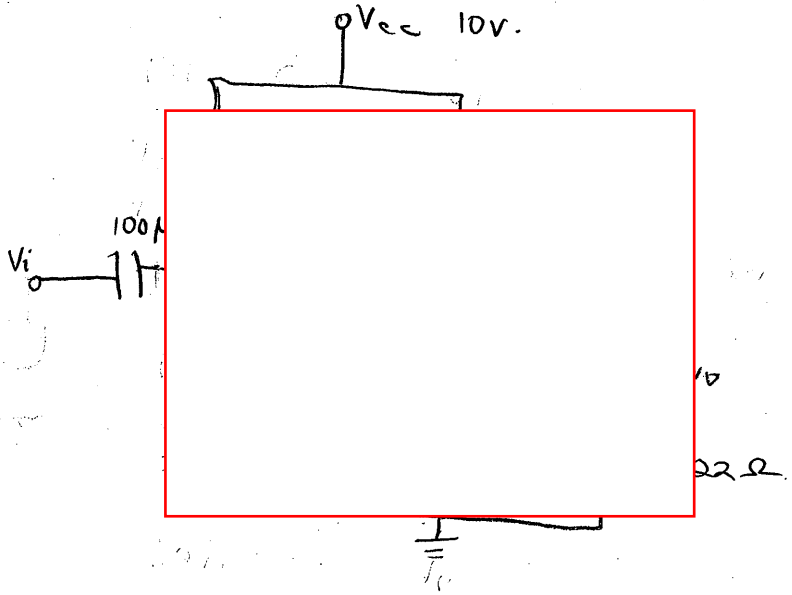
Class 'A' power amplifier was designed as shown in the design and calculation section. R2 resistor was obtained using a potentiometer. To obtained a biased amplifier circuit, Vce was measured using a multimeter while the potentiometer adjusted to obtain a Vce of ½(Vcc), then the pot resistance noted. The resistor was experimentally obtained to be 131Ω, which was a bit higher than the calculated value of 116Ω. Input and output waveform was displayed on the o[redacted]as 0

Conclusion

Class 'AB' power amplifier appeared to be a better choice because the efficiency was reasonable compared to the other power amplifiers, and no distortion was observed. Class 'B' power amplifier had a higher efficiency but the distorted output was the problem. Class 'A' power amplifier had a lower efficiency compared to the other two power amplifier.

CLASS 'A' P.A

Load Resistor =



$V_{CE} = \frac{1}{2} V_{cc} = \frac{1}{2}(10) = 5V$

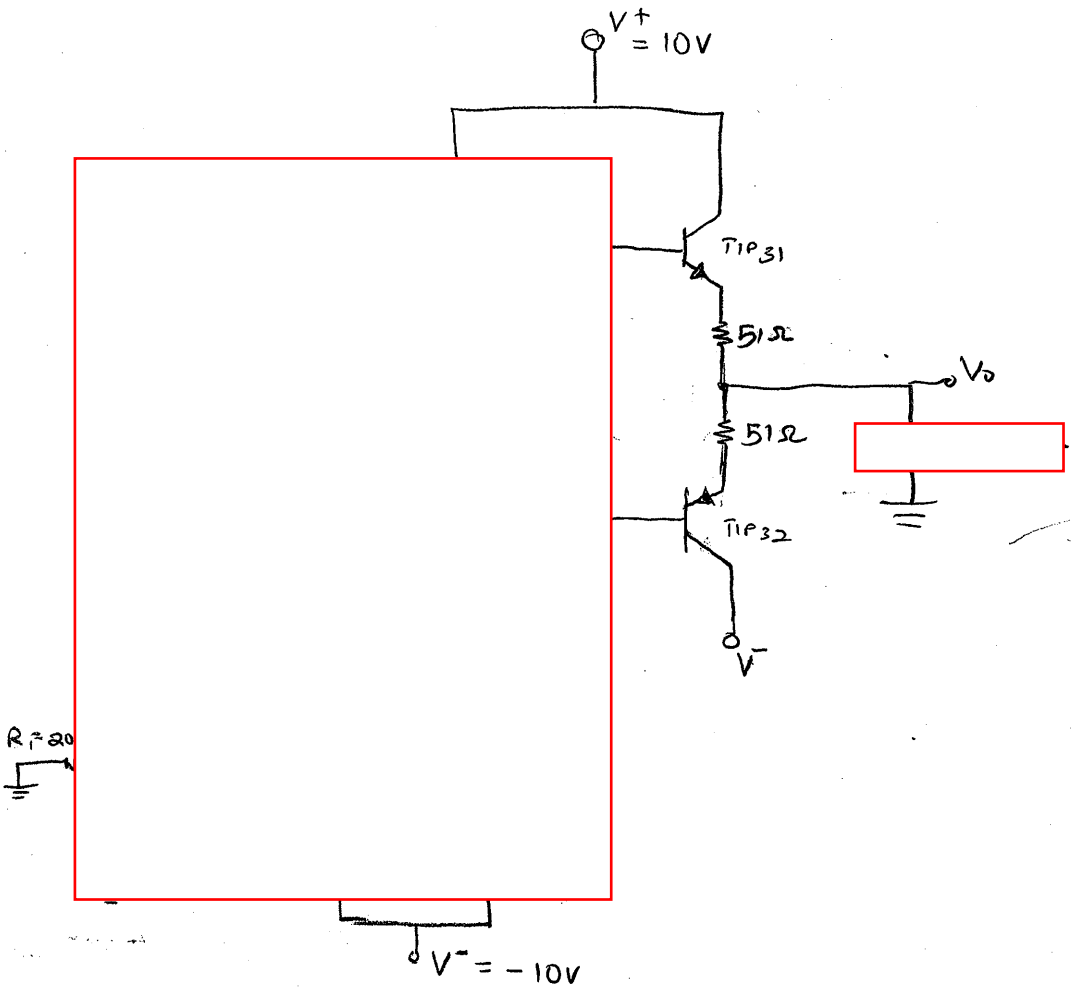
$V_{RE} = 5V$

$V_{cc} = 10V$

$I_{cq} = 0.249\,A$

DESIGN AND CALCULATION

(1) CLASS 'AB' P.A



Measured Values

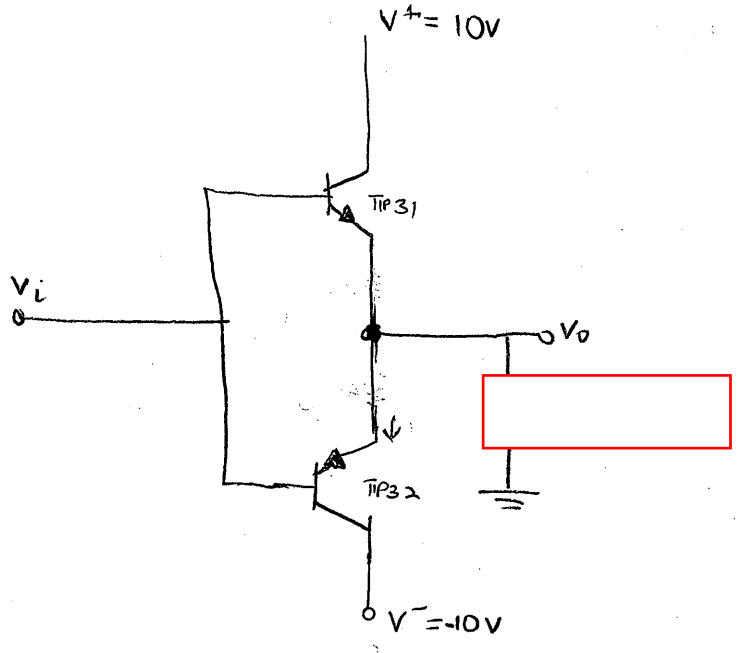
R_1 = 250Ω

= 6.25

437.8mW

= 11.665%

CLASS 'B' P.A



Measured Values

$I_{cq} = 0.1634\ A$

$I_{cp} = 0.1653\ A$

$V_p = 11.87\ V$

$V_{cc} = 10\ V$

	Frequency (Hz)	V-values (V)
V_1	1041	2.172
V_2	2002	0.1171
V_3	2962	0.09652
V_4	5044	0.05769
V_5	7126	0.03086
V_6	9047	0.02455

$$\therefore THD = \frac{V_2^2 + V_3^2 + V_4^2 + V_5^2 + V_6^2}{V_1^2} \times 100$$

$$= \frac{0.1171^2 + 0.09652^2 + 0.05769^2 + 0.03086^2 + 0.02455^2}{2.172^2}$$

$$= 5.917 \times 10^{-3} \times 100$$

$$= 0.5917\ \%$$

$$= \frac{0.7596}{3.268} \times 100$$

$$= 23.24\ \%$$

RESULTS AND PLOTS

Op-Amp gain

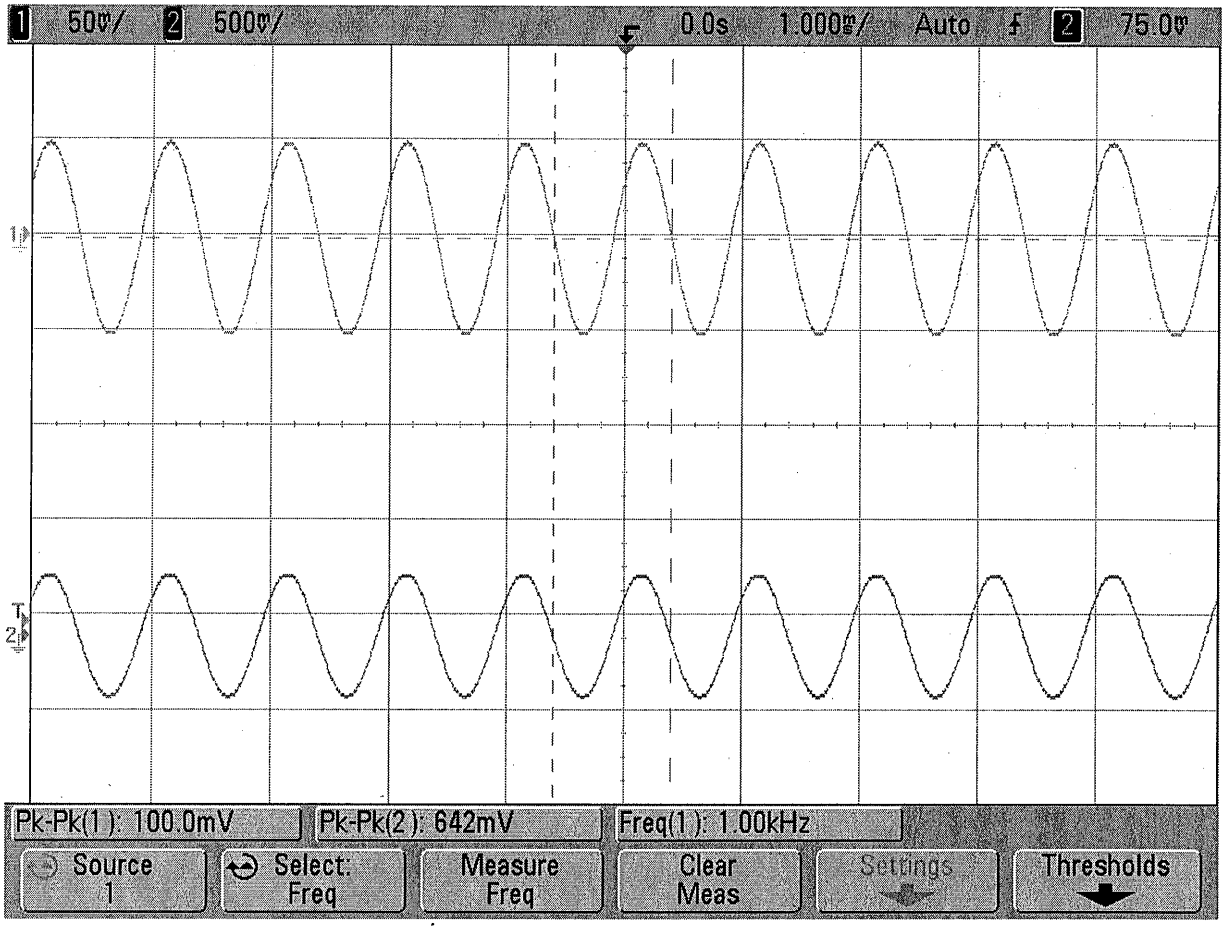


Figure 1: Op-Amp input and output waveform. Observed gain was 6.42

Driver circuit input and output measurements

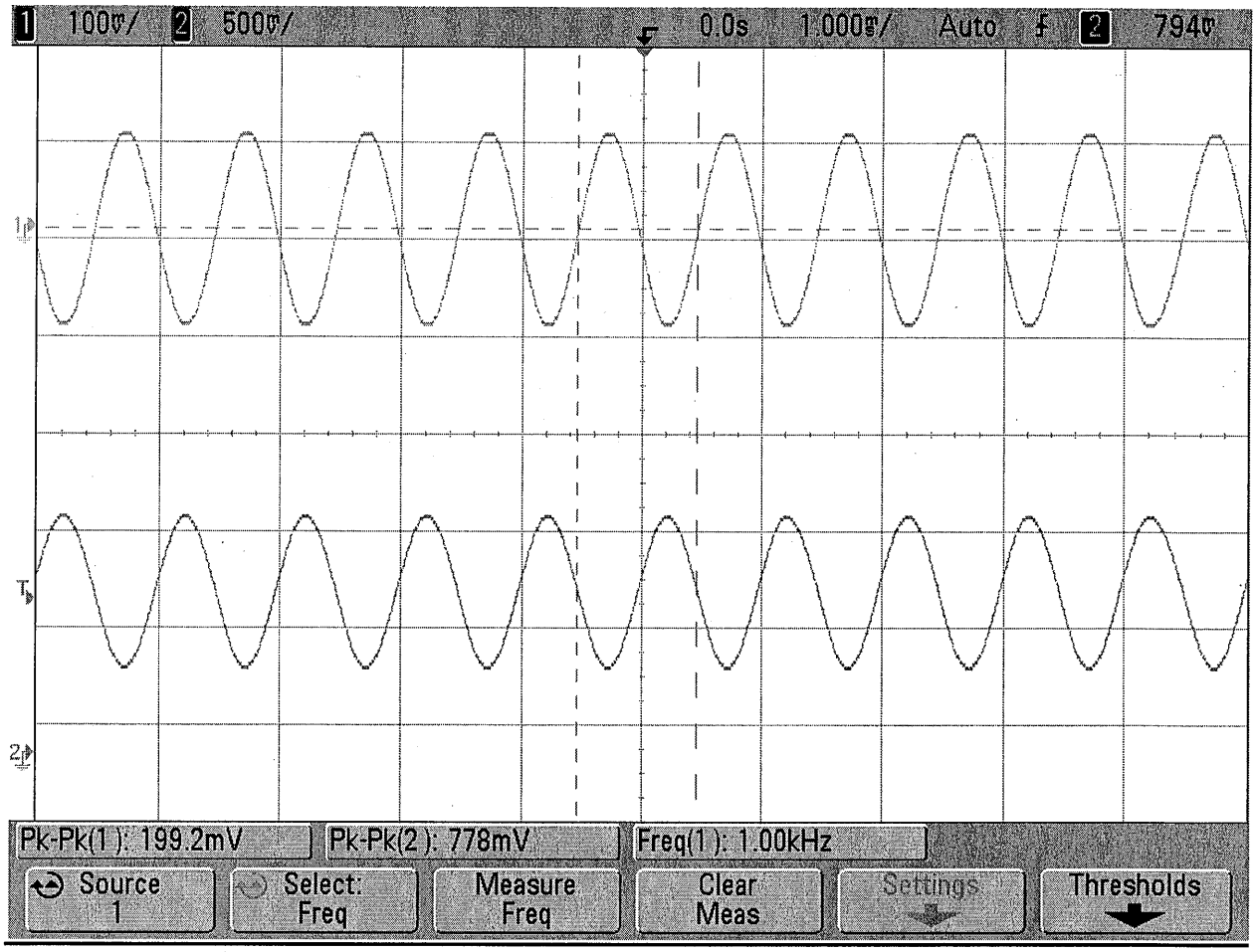


Figure 2: Driver circuit output (Green waveform). Gain of this stage was calculated using the output of the op-amp stage and the output of this stage. Gain = 0.825

Class 'AB' Power Amplifier

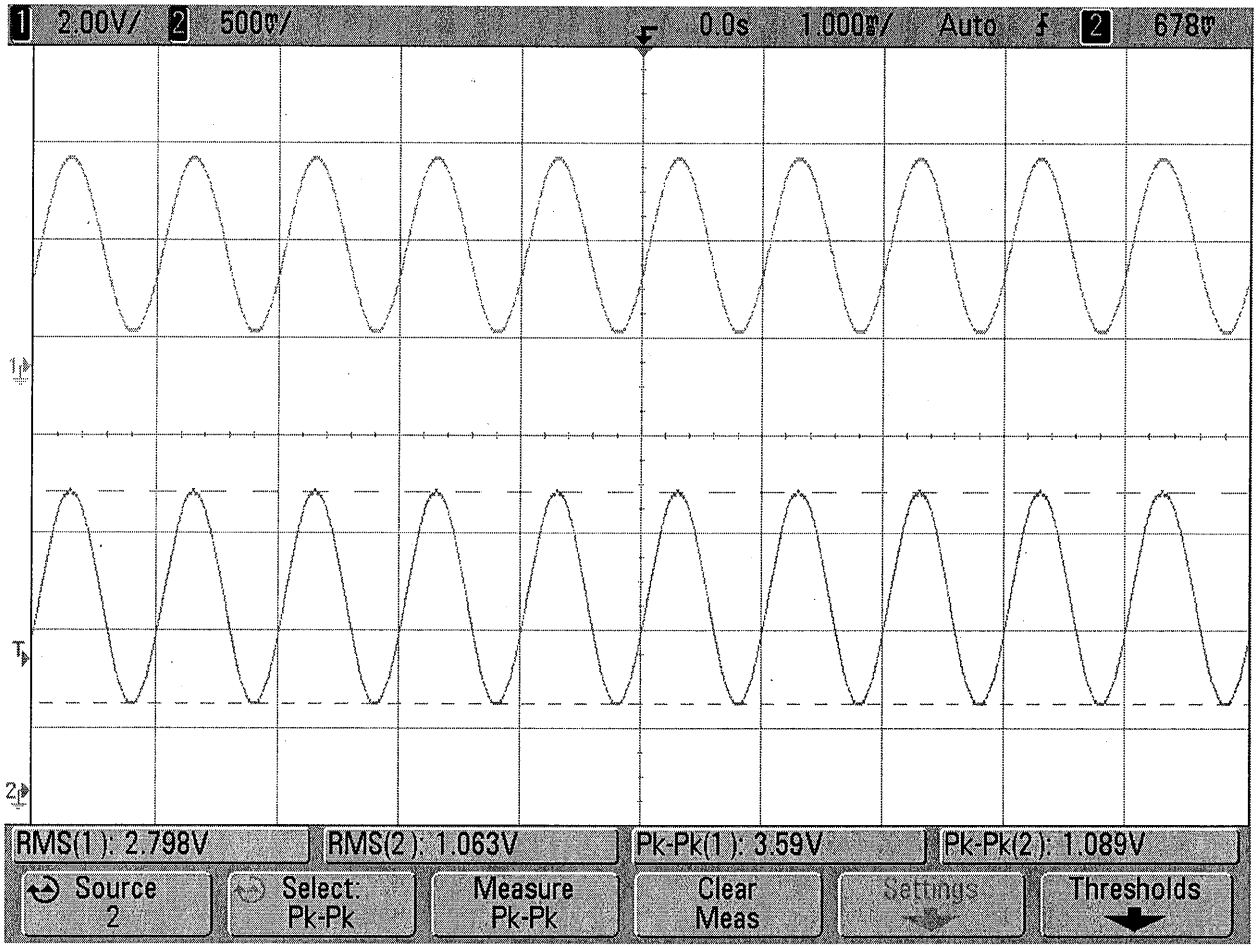


Figure 3: Input and output waveform for class 'AB' power amplifier. Attenuation of the input voltage was observed

Class 'B' Power Amplifier

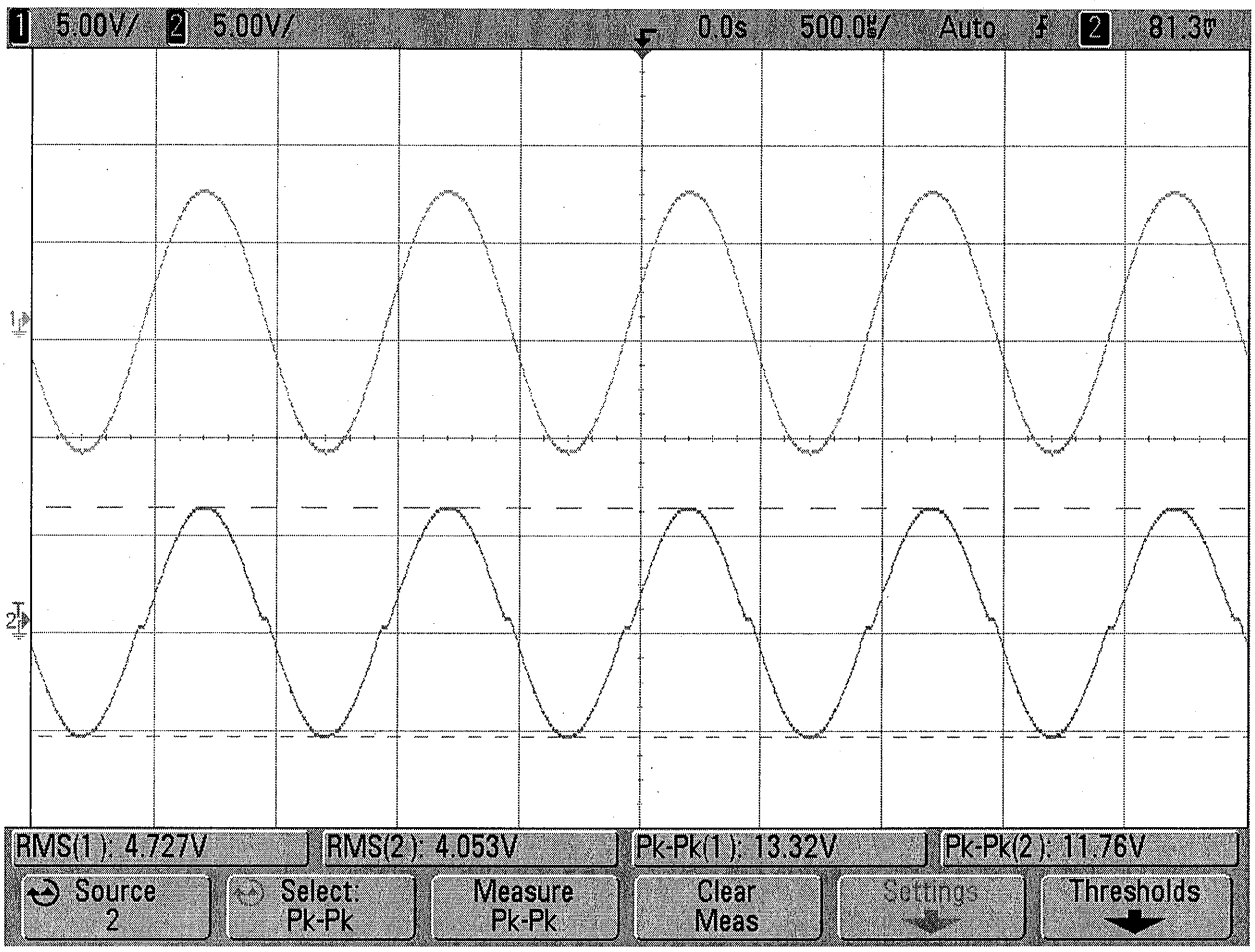


Figure 4: Input and output waveform for class 'B' Power amplifier. Distortion was observed and total harmonic distortion was calculated

Class 'B' Harmonics (FFT)

```
clear all
close all
clc

[v,T,vT] = xlsread('class_b.xlsx');
t = v(:,1);
x = v(:,2);

dt=t(2)-t(1);
Fs=1/dt;
NFFT=length(x);
Y=fft(x,NFFT)/(length(x));
X = fftshift(Y);
f=linspace(-Fs/2,Fs/2,length(X));
figure
subplot(2,1,1)
plot(f,abs(X),'r')
subplot(2,1,2)
plot(f,angle(X),'r')
```

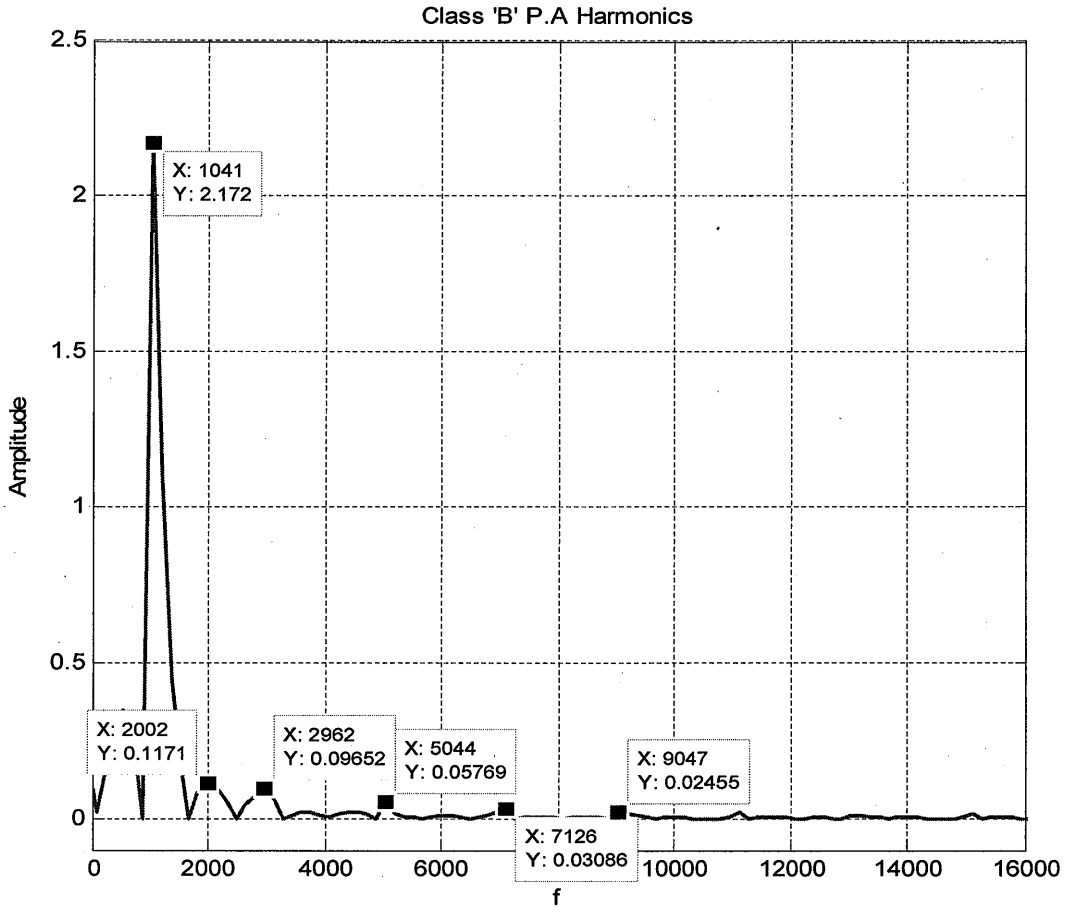


Figure 5: Frequency domain plot of class B output waveform

Class 'A' Power Amplifier

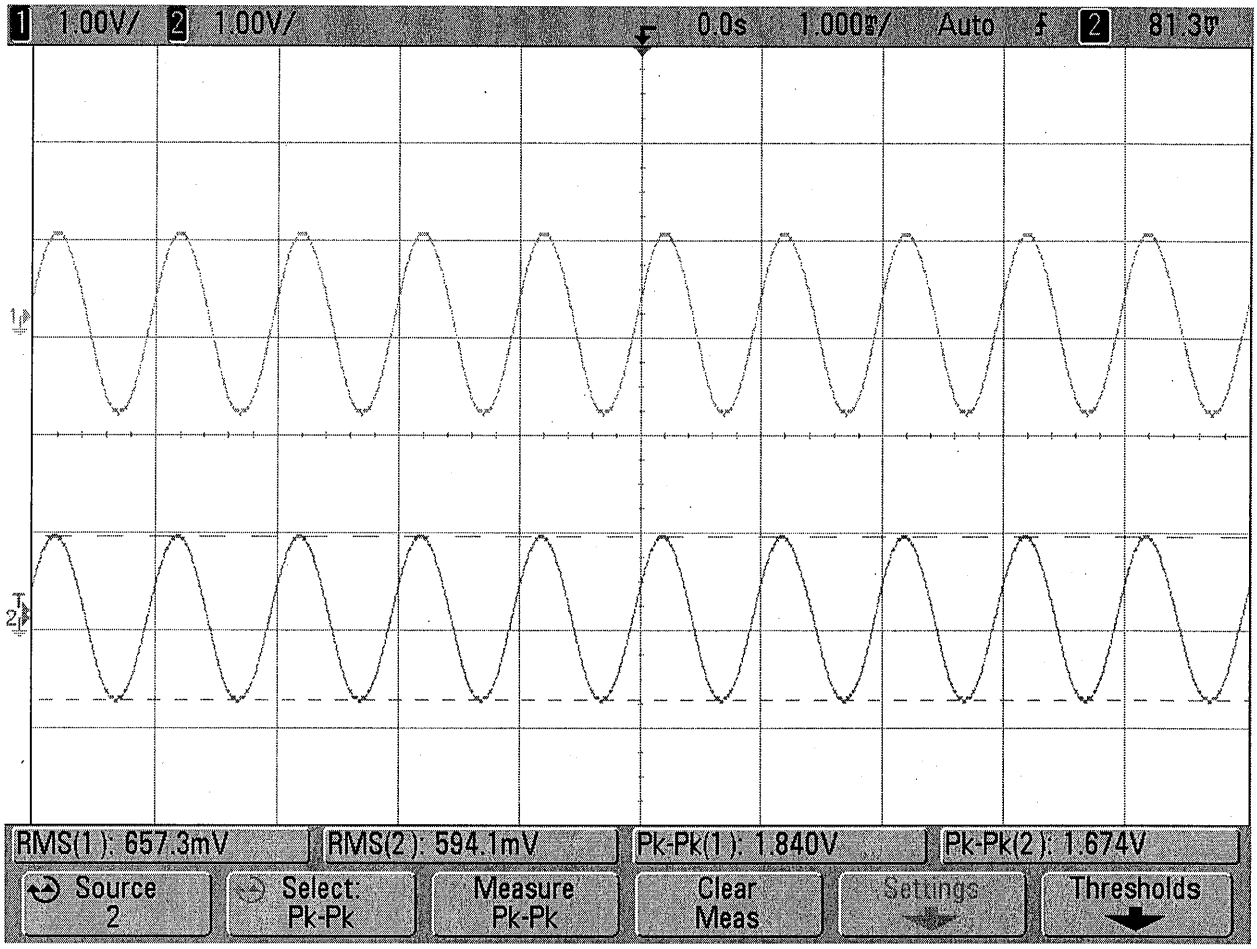


Figure 6: Input and output waveform of class 'A' Power amplifier. Attenuation of the input voltage was observed