

Figure 1

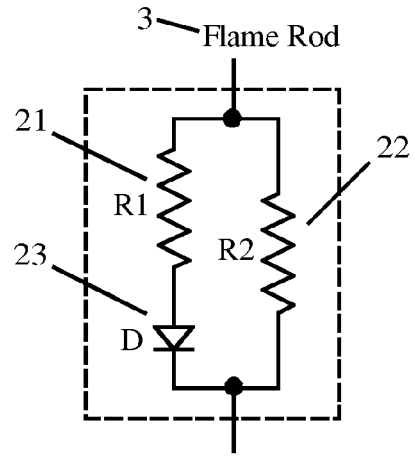


Figure 2

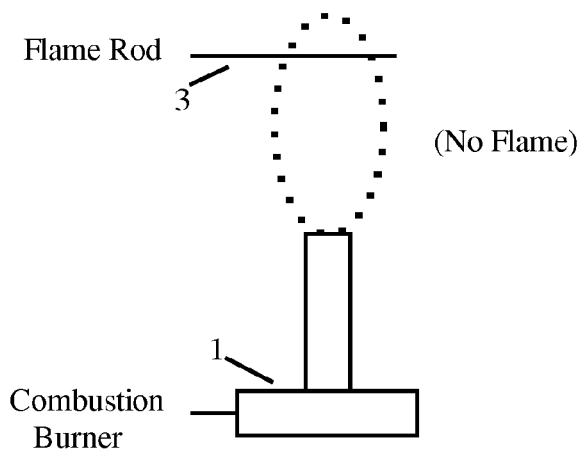


Figure 3

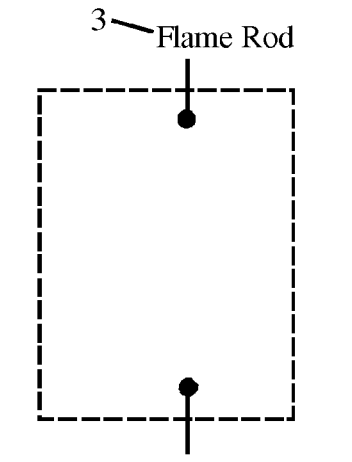


Figure 4

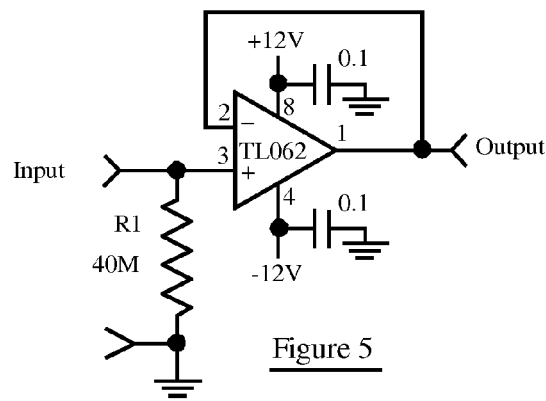
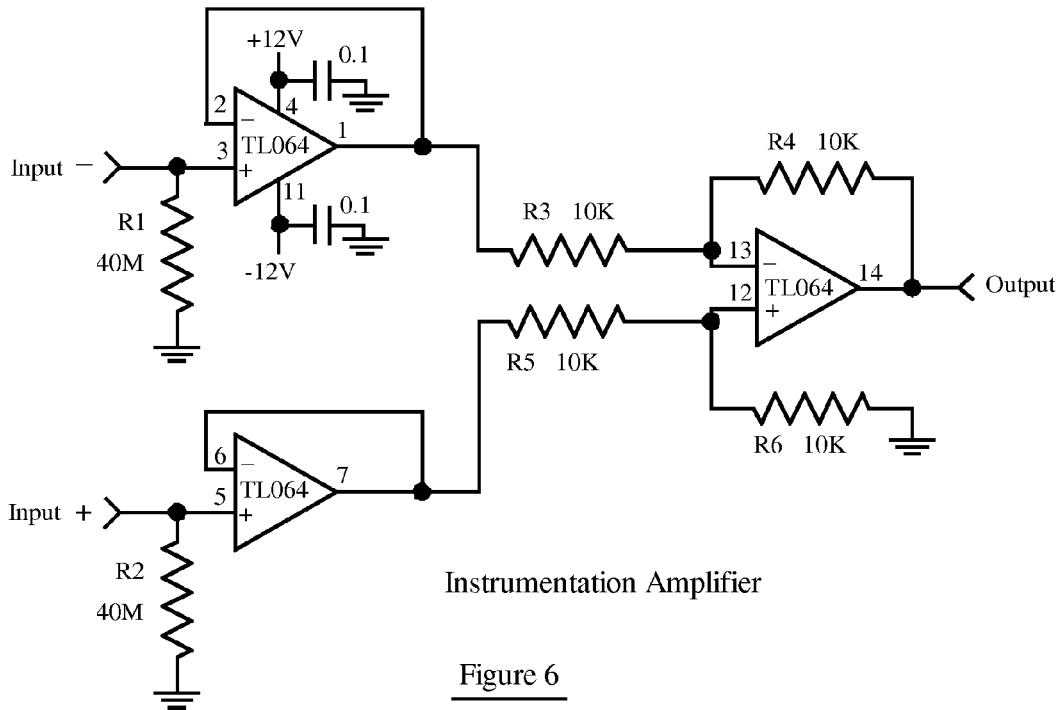


Figure 5



Instrumentation Amplifier

Figure 6

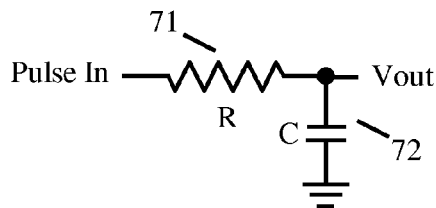


Figure 7

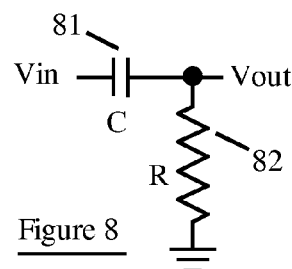


Figure 8

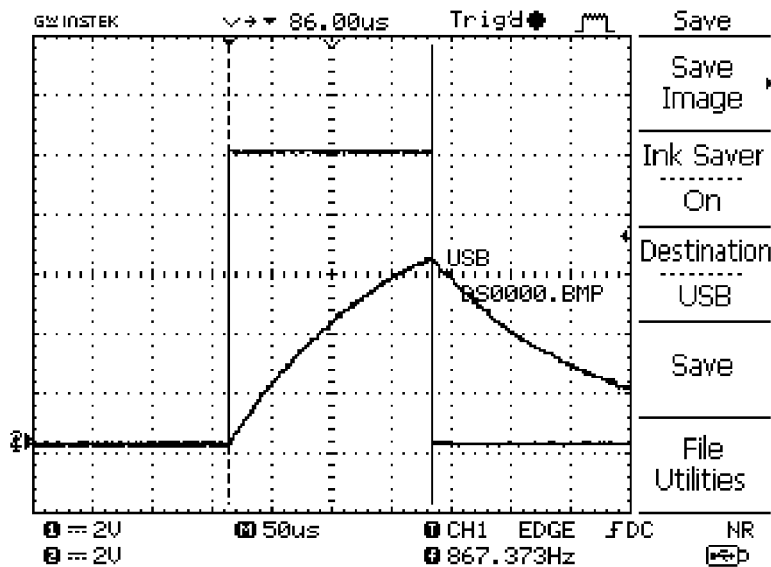


Figure 9

Table 2

$$\frac{V_{out}}{V_{in}} = \frac{R}{R + 1/(s*C)} \quad H(s) = \frac{s}{s + 1/(R*C)}$$

Substitute $s = j\omega$

$$H(j\omega) = \frac{j\omega}{j\omega + 1/(R*C)}$$

$$\text{The magnitude response } |H(j\omega)| = \frac{\omega}{\text{Sqrt}(\omega^2 + 1/(R*C)^2)}$$

$$\text{The Phase Response } \theta(j\omega) = 90^\circ - \tan^{-1}(\omega*R*C)$$

Where $\omega = 2 * \pi * \text{Frequency}$

Therefore, for

- $V_{in} = 120 \text{ VAC}$ (120)
- $R = 1 \text{ megohm}$ ($1*10^6$)
- $C = 160 \text{ pF}/10*2.5$ ($40*10^{-12}$)
- $\text{Frequency} = 60 \text{ Hz}$ (60)

The magnitude of V_{out} is approximately 1.81 VAC
 The phase response is a phase lead of approximately 8.9 degrees.

Figure 10

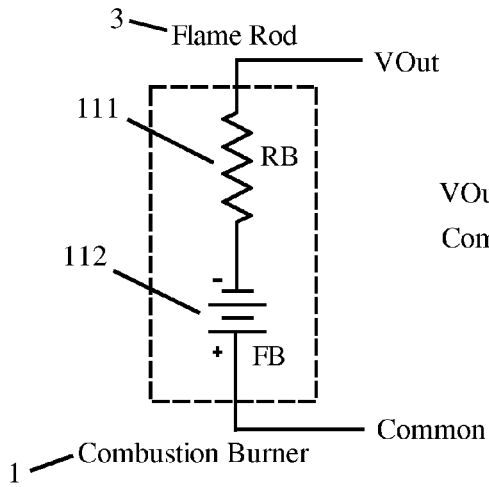


Figure 11

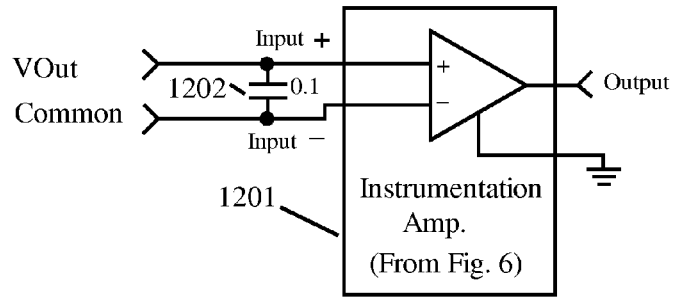


Figure 12

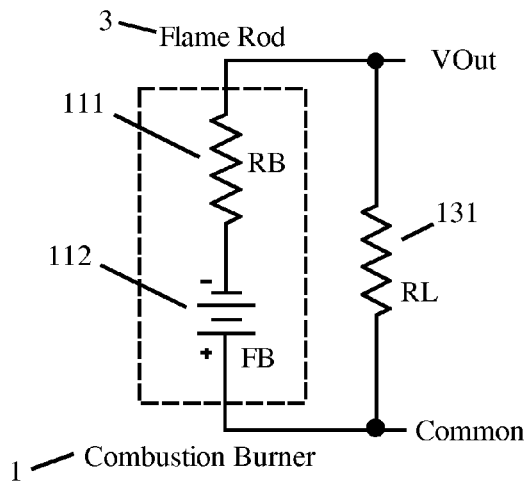


Figure 13

Table 5.4 (continued)

No.	Reaction	Forward Rate Coefficient*		
		A	b	E
<i>N-Containing Reactions (continued)</i>				
201	$\text{NH}_2 + \text{O} \rightarrow \text{H} + \text{HNO}$	3.9E + 13	0.0	0.0
202	$\text{NH}_2 + \text{H} \rightarrow \text{NH} + \text{H}_2$	4.00E + 13	0.0	3,650
203	$\text{NH}_2 + \text{OH} \rightarrow \text{NH} + \text{H}_2\text{O}$	9.00E + 07	1.5	-460
204	$\text{NNH} \rightarrow \text{N}_2 + \text{H}$	3.30E + 08	0.0	0.0
205	$\text{NNH} + \text{M} \rightarrow \text{N}_2 + \text{H} + \text{M}$	1.30E + 14	-0.1	4,980
206	$\text{NNH} + \text{O}_2 \rightarrow \text{HO}_2 + \text{N}_2$	5.00E + 12	0.0	0.0
207	$\text{NNH} + \text{O} \rightarrow \text{OH} + \text{N}_2$	2.50E + 13	0.0	0.0
208	$\text{NNH} + \text{O} \rightarrow \text{NH} + \text{NO}$	7.00E + 13	0.0	0.0
209	$\text{NNH} + \text{H} \rightarrow \text{H}_2 + \text{N}_2$	5.00E + 13	0.0	0.0
210	$\text{NNH} + \text{OH} \rightarrow \text{H}_2\text{O} + \text{N}_2$	2.00E + 13	0.0	0.0
211	$\text{NNH} + \text{CH}_3 \rightarrow \text{CH}_4 + \text{N}_2$	2.50E + 13	0.0	0.0
212	$\text{H} + \text{NO} + \text{M} \rightarrow \text{HNO} + \text{M}$	4.48E + 19	-1.3	740
213	$\text{HNO} + \text{O} \rightarrow \text{NO} + \text{OH}$	2.50E + 13	0.0	0.0
214	$\text{HNO} + \text{H} \rightarrow \text{H}_2 + \text{NO}$	9.00E + 11	0.7	660
215	$\text{HNO} + \text{OH} \rightarrow \text{NO} + \text{H}_2\text{O}$	1.30E + 07	1.9	-950
216	$\text{HNO} + \text{O}_2 \rightarrow \text{HO}_2 + \text{NO}$	1.00E + 13	0.0	13,000
217	$\text{CN} + \text{O} \rightarrow \text{CO} + \text{N}$	7.70E + 13	0.0	0.0
218	$\text{CN} + \text{OH} \rightarrow \text{NCO} + \text{H}$	4.00E + 13	0.0	0.0
219	$\text{CN} + \text{H}_2\text{O} \rightarrow \text{HCN} + \text{OH}$	8.00E + 12	0.0	7,460
220	$\text{CN} + \text{O}_2 \rightarrow \text{NCO} + \text{O}$	6.14E + 12	0.0	-440
221	$\text{CN} + \text{H}_2 \rightarrow \text{HCN} + \text{H}$	2.95E + 05	2.5	2,240
222	$\text{NCO} + \text{O} \rightarrow \text{NO} + \text{CO}$	2.35E + 13	0.0	0.0
223	$\text{NCO} + \text{H} \rightarrow \text{NH} + \text{CO}$	5.40E + 13	0.0	0.0
224	$\text{NCO} + \text{OH} \rightarrow \text{NO} + \text{H} + \text{CO}$	2.50E + 12	0.0	0.0
225	$\text{NCO} + \text{N} \rightarrow \text{N}_2 + \text{CO}$	2.00E + 13	0.0	0.0
226	$\text{NCO} + \text{O}_2 \rightarrow \text{NO} + \text{CO}_2$	2.00E + 12	0.0	20,000
227	$\text{NCO} + \text{M} \rightarrow \text{N} + \text{CO} + \text{M}$	3.10E + 14	0.0	54,050
228	$\text{NCO} + \text{NO} \rightarrow \text{N}_2\text{O} + \text{CO}$	1.90E + 17	-1.5	740
229	$\text{NCO} + \text{NO} \rightarrow \text{N}_2 + \text{CO}_2$	3.80E + 18	-2.0	800
230	$\text{HCN} + \text{M} \rightarrow \text{H} + \text{CN} + \text{M}$	1.04E + 29	-3.3	126,600
231	$\text{HCN} + \text{O} \rightarrow \text{NCO} + \text{H}$	2.03E + 04	2.6	4,980
232	$\text{HCN} + \text{O} \rightarrow \text{NH} + \text{CO}$	5.07E + 03	2.6	4,980
233	$\text{HCN} + \text{O} \rightarrow \text{CN} + \text{OH}$	3.91E + 09	1.6	26,600
234	$\text{HCN} + \text{OH} \rightarrow \text{HOCN} + \text{H}$	1.10E + 06	2.0	13,370
235	$\text{HCN} + \text{OH} \rightarrow \text{HNCO} + \text{H}$	4.40E + 03	2.3	6,400
236	$\text{HCN} + \text{OH} \rightarrow \text{NH}_2 + \text{CO}$	1.60E + 02	2.6	9,000
237	$\text{H} + \text{HCN} + \text{M} \rightarrow \text{H}_2\text{CN} + \text{M}$		pressure dependent	
238	$\text{H}_2\text{CN} + \text{N} \rightarrow \text{N}_2 + \text{CH}_2$	6.00E + 13	0.0	400
239	$\text{C} + \text{N}_2 \rightarrow \text{CN} + \text{N}$	6.30E + 13	0.0	46,020
240	$\text{CH} + \text{N}_2 \rightarrow \text{HCN} + \text{N}$	3.12E + 09	0.9	20,130
241	$\text{CH} + \text{N}_2 (+ \text{M}) \rightarrow \text{HCNN} (+ \text{M})$		pressure dependent	
242	$\text{CH}_2 + \text{N}_2 \rightarrow \text{HCN} + \text{NH}$	1.00E + 13	0.0	74,000
243 ^b	$\text{CH}_2(\text{S}) + \text{N}_2 \rightarrow \text{NH} + \text{HCN}$	1.00E + 11	0.0	65,000

Figure 14 (from Turns)

Table 1

Table 17.12 Composition (mol%) and properties of natural gas from sources in the United States [28]^a

Location	CH ₄	C ₂ H ₆	C ₃ H ₈	C ₄ H ₁₀	CO ₂	N ₂	Density ^c (kg/m ³)	HHV ^d (kJ/M ³)	HHV ^d (kJ/hg)
Alaska	99.6	—	—	—	—	0.4	0.686	37,590	54,800
Birmingham,	90.0	5.0	—	—	—	5.0	0.735	37,260	50,690
East Ohio ^b	94.1	3.01	0.42	0.28	0.71	1.41	0.723	38,260	52,940
Kansas City,	84.1	6.7	—	—	0.8	8.4	0.772	36,140	46,830
Pittsburgh,	83.4	15.8	—	—	—	0.8	0.772	41,840	54,215

^a Although not explicitly stated in Ref. [28], these gases appear to be pipeline gases.
^b Also contains 0.01 % H₂ and 0.01% O₂.
^c At 1 atm and 15.6°C (60 F).
^d Higher heating values for 1 atm and 15.6°C (60 F) [28].

Figure 15 (Turns Table 17.12)

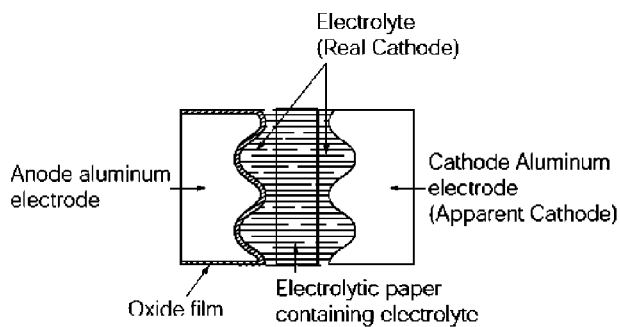


Fig. 1 - 1

Figure 16 (Nichicon Figure 1-1)

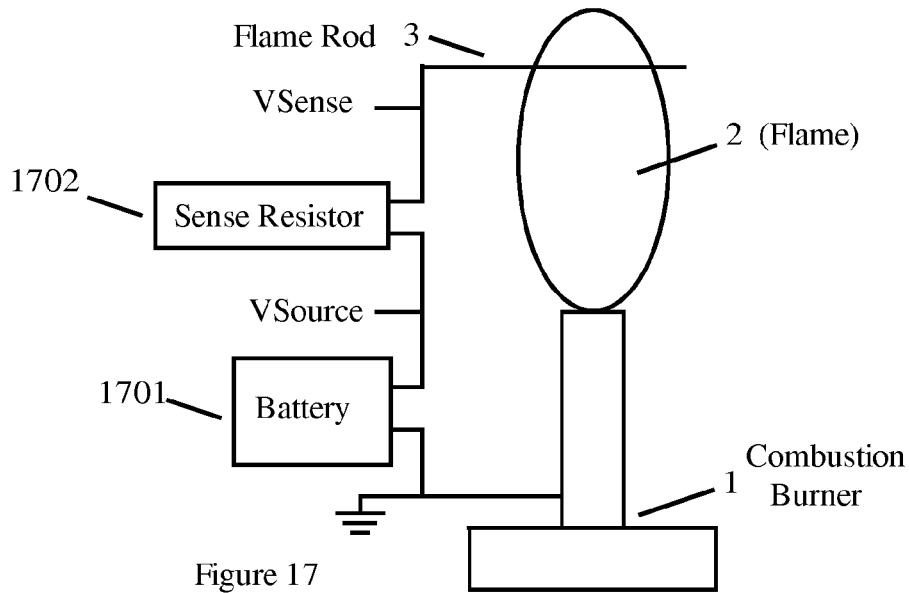


Figure 17

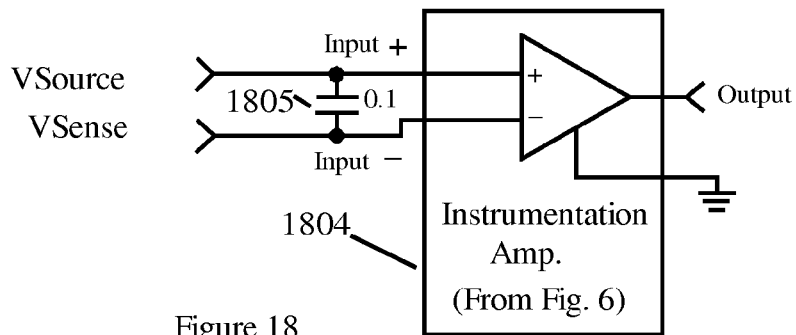
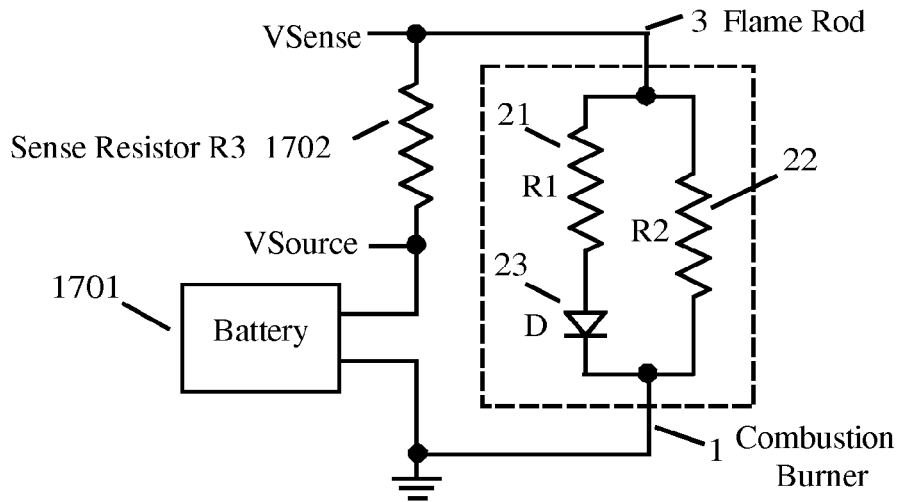
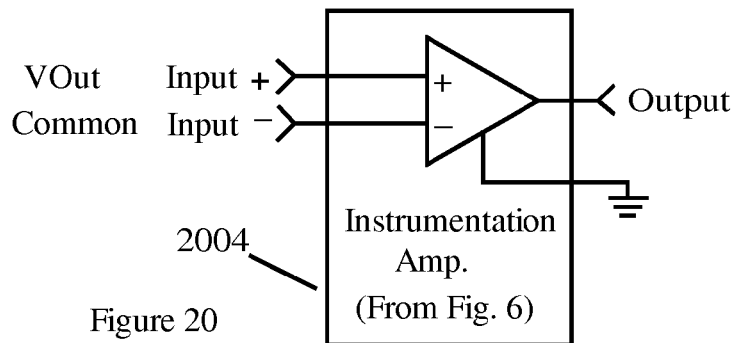
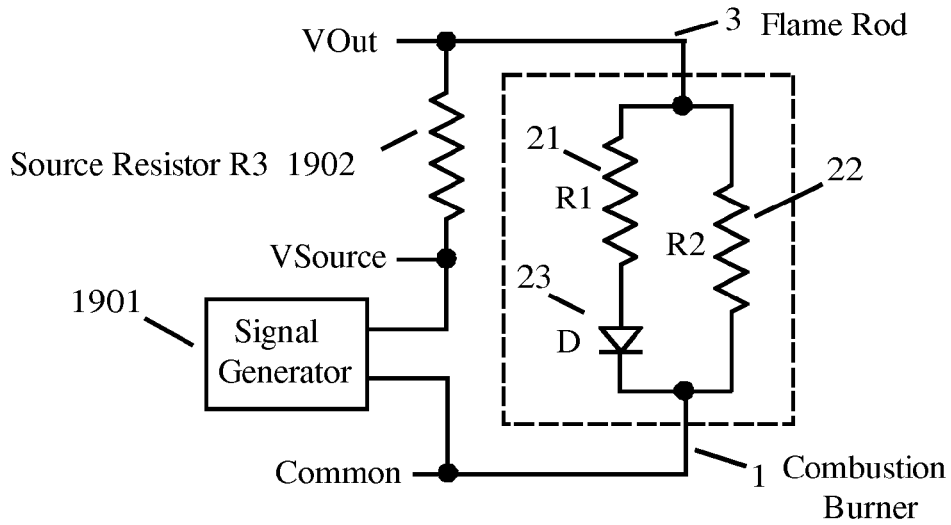
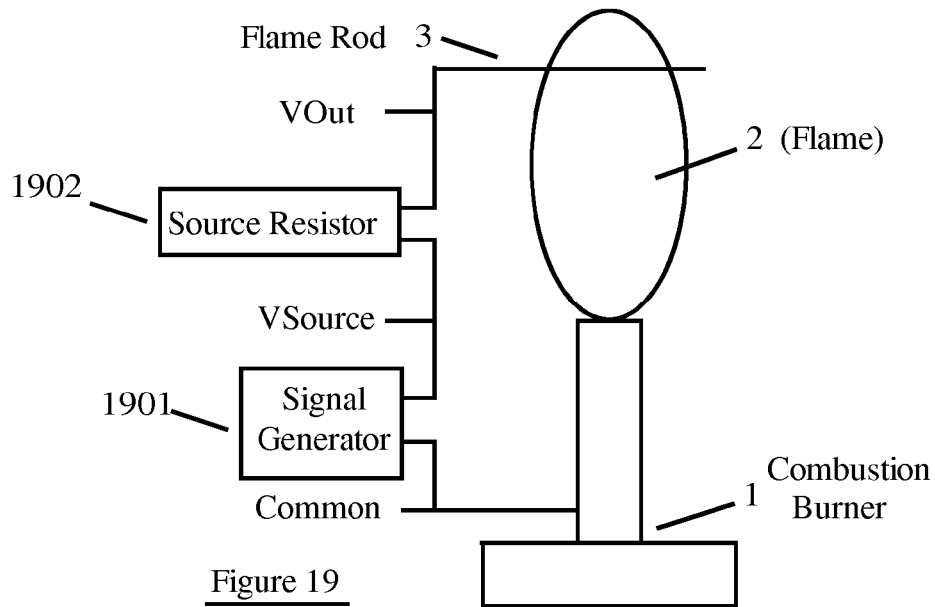


Figure 18



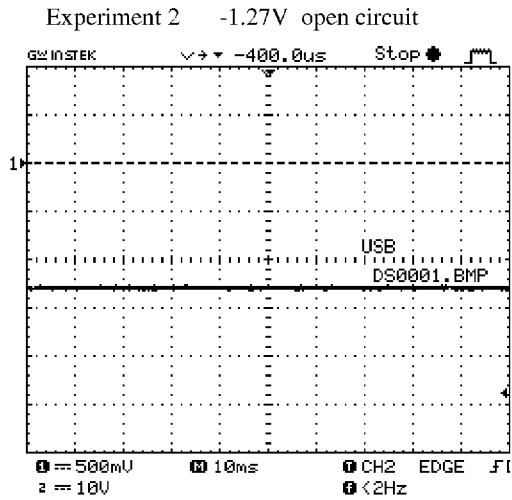


Figure 21a

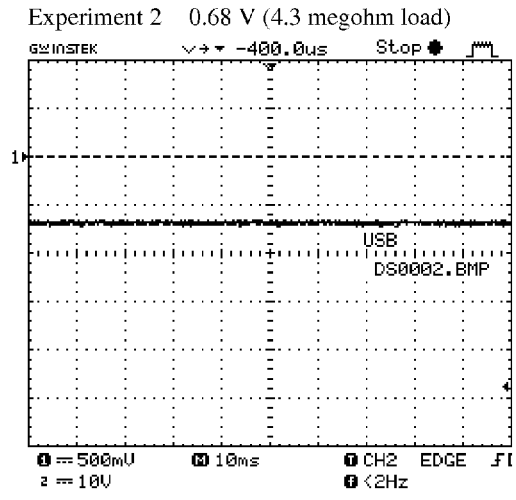


Figure 21b

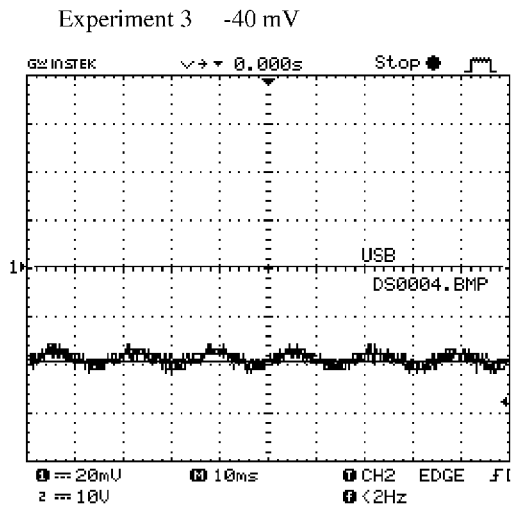


Figure 22a

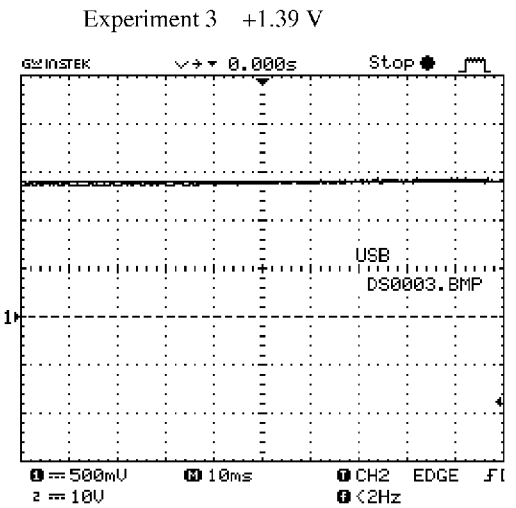


Figure 22b

Experiment 4 100 Hz +2.79 V to -7.2 V

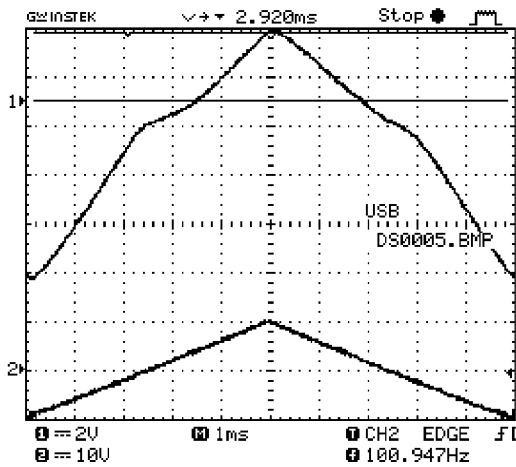


Figure 23a

Experiment 4 Leading Edge -960 mV to 0 V

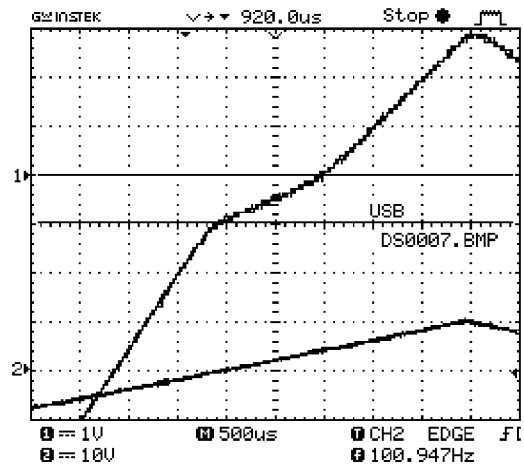


Figure 23b

Experiment 4 Trailing Edge -640 mV to -1.20 V

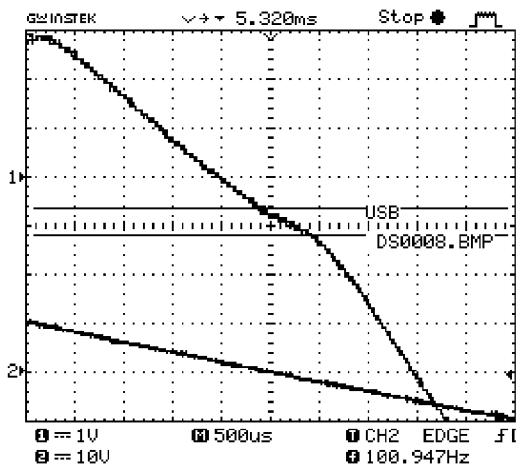


Figure 23c

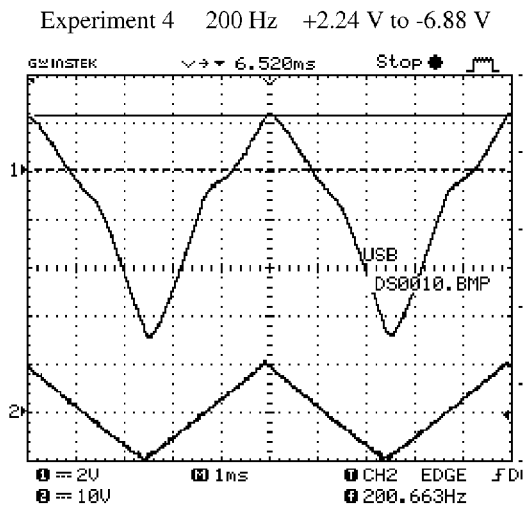


Figure 24a

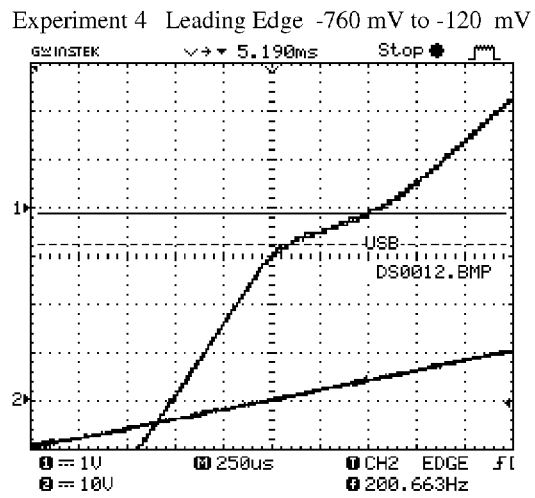


Figure 24b

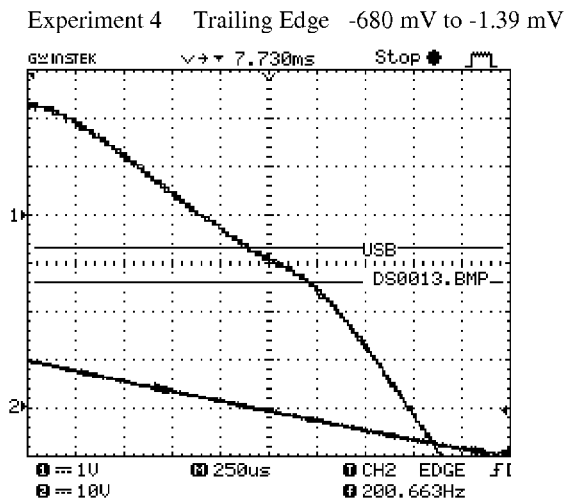


Figure 24c

Experiment 4 400 Hz +1.84 V to -6.32 V

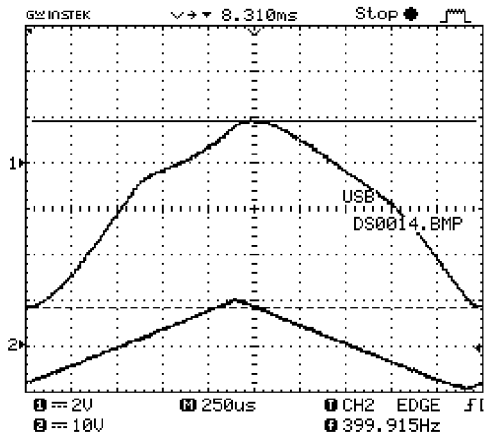


Figure 25a

Experiment 4 Leading Edge -440 mV to +200 mV

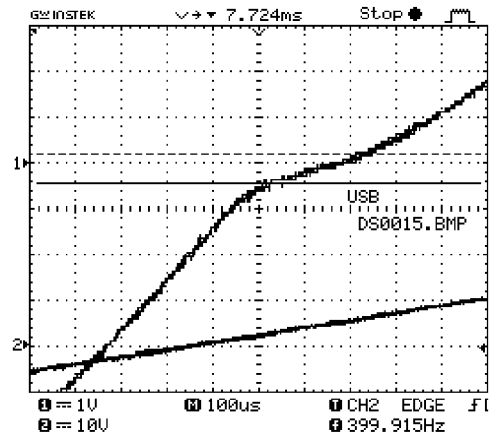


Figure 25b

Experiment 4 Trailing Edge -1.63 V to -2.0 V

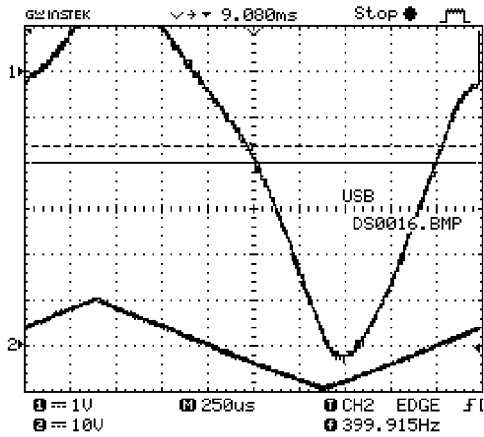


Figure 25c

Experiment 4 1KHz +0.920 V to -4.88 V

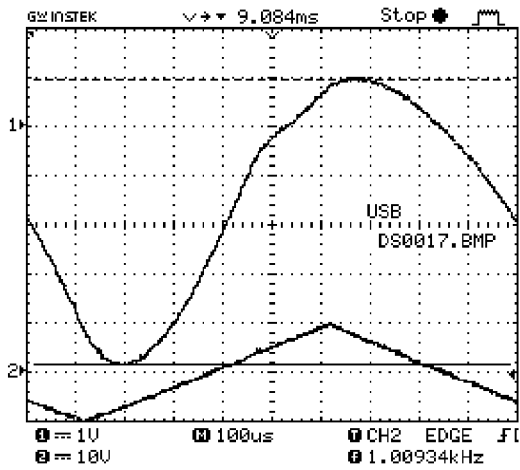


Figure 26a

Experiment 4 Leading Edge -340 mV to +440 mV

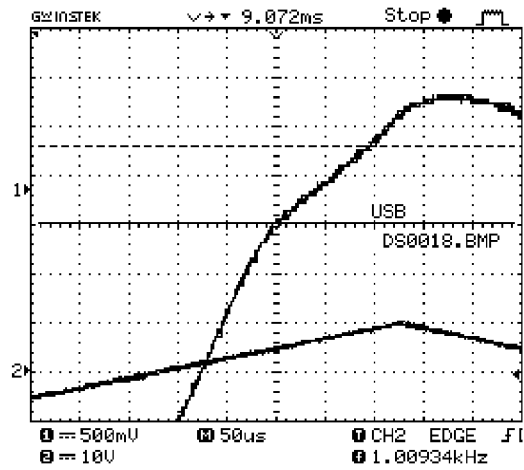


Figure 26b

Experiment 4 Trailing Edge - Indistinct

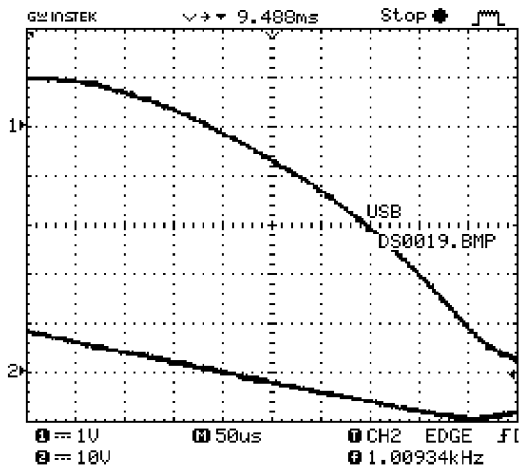


Figure 26c

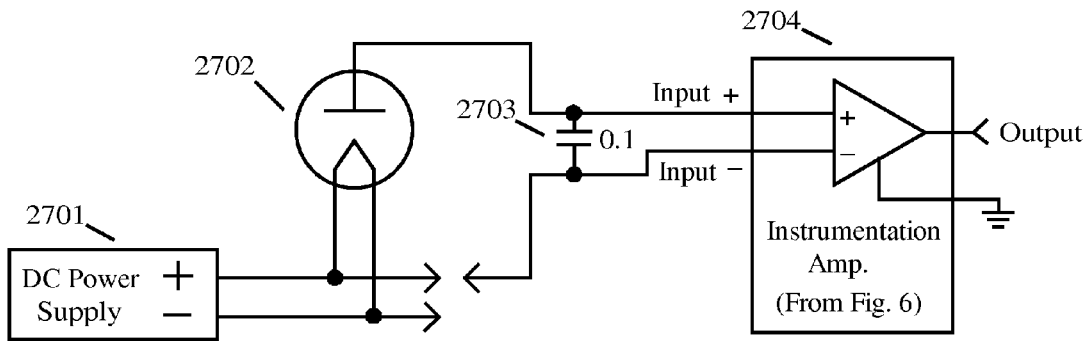


Figure 27

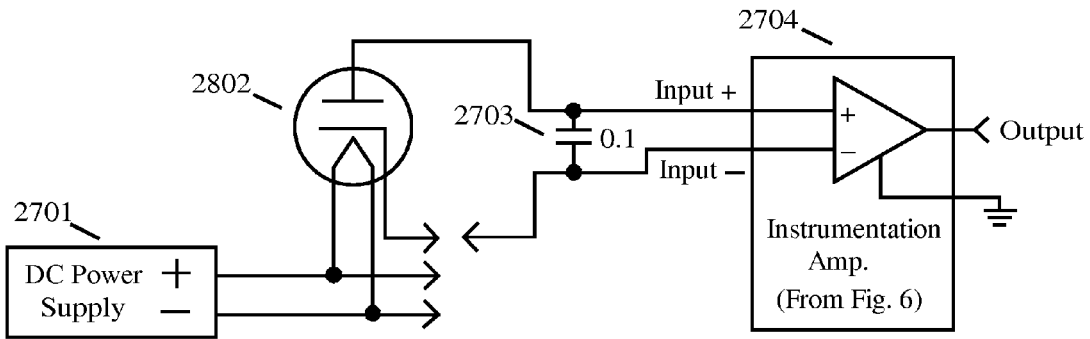


Figure 28

Table 4 - Thermionic Emission Test – 5U4GB Vacuum Tube

5U4GB	#1 Westinghouse	1/12/14		jm
2	Filament(2)		0V	+5 VDC 2.94A
8	Filament(8)		+5 VDC 2.93A	0V
2	Filament(2)		Ref	Ref
4	Plate 1		-0.93V	-3.46V
6	Plate 2		-0.01V	-5.59V
8	Filament(8)		Ref	Ref
4	Plate 1		-5.68V	-0.09V
6	Plate 2		-3.30V	-0.84V

Figure 29

Table 5 - Thermionic Emission Test – 5Y3 Vacuum Tube

5Y3	#1 RCA	1/12/2014		jm
2	Filament(2)		0V	+5 VDC 2.00A
8	Filament(8)		+5 VDC 1.98A	0V
2	Filament(2)		Ref	Ref
4	Plate 1		-0.61V	-3.04V
6	Plate 2		0.0V	-5.25V
8	Filament(8)		Ref	Ref
4	Plate 1		-5.37V	0.0V
6	Plate 2		-3.00V	-0.51V

Figure 30

Table 6 - Thermionic Emission Test – 6X4 Vacuum Tube

6X4 #1 Raytheon		1/13/14 jm			
3	Filament(3)	0V	3	Filament(3)	+6.3DC 0.60A
4	Filament(4)	+6.3VDC 0.59A	4	Filament(4)	0V
7	Cathode	Ref	7	Cathode	Ref
6	Plate 1	-0.91V	6	Plate 1	-0.92V
1	Plate 2	-1.14V	1	Plate 2	-1.17V
7,3	Cathode, Filament(3)	Ref	7,3	Cathode, Filament(3)	Ref
6	Plate 1	-0.91V	6	Plate 1	-0.93V
1	Plate 2	-1.16V	1	Plate 2	-1.18V
7,4	Cathode, Filament(4)	Ref	7,4	Cathode, Filament(4)	Ref
6	Plate 1	-0.91V	6	Plate 1	-0.93V
1	Plate 2	-1.16V	1	Plate 2	-1.19V
3	Filament(3)	Ref	3	Filament(3)	Ref
7	Cathode	+2.50V	7	Cathode	-3.67V
4	Filament(4)	Ref	4	Filament(4)	Ref
7	Cathode	-3.66V	7	Cathode	+2.52V

Figure 31

Table 7 - Thermionic Emission Test – 12X4 Vacuum Tube

12X4 #1 RCA			01/13/2014 jm		
3	Filament	0V	3	Filament	+12.6 VDC 0.32A
4	Filament	+12.6 VDC 0.32A	4	Filament	0V
7	Cathode	Ref	7	Cathode	Ref
6	Plate 1	-1.17V	6	Plate 1	-1.17V
1	Plate 2	-1.04V	1	Plate 2	-1.05V
7,3	Cathode, Filament(3)	Ref	7,3	Cathode, Filament(3)	Ref
6	Plate 1	-1.17V	6	Plate 1	-1.17V
1	Plate 2	-1.04V	1	Plate 2	-1.05V
7,4	Cathode, Filament(4)	Ref	7,4	Cathode, Filament(4)	Ref
6	Plate 1	-1.17V	6	Plate 1	-1.17V
1	Plate 2	-1.05V	1	Plate 2	-1.05V
3	Filament(3)	Ref	3	Filament(3)	Ref
7	Cathode	+1.66V	7	Cathode	-4.70V
4	Filament(4)	Ref	4	Filament(4)	Ref
7	Cathode	-4.70V	7	Cathode	+1.83V

Figure 32

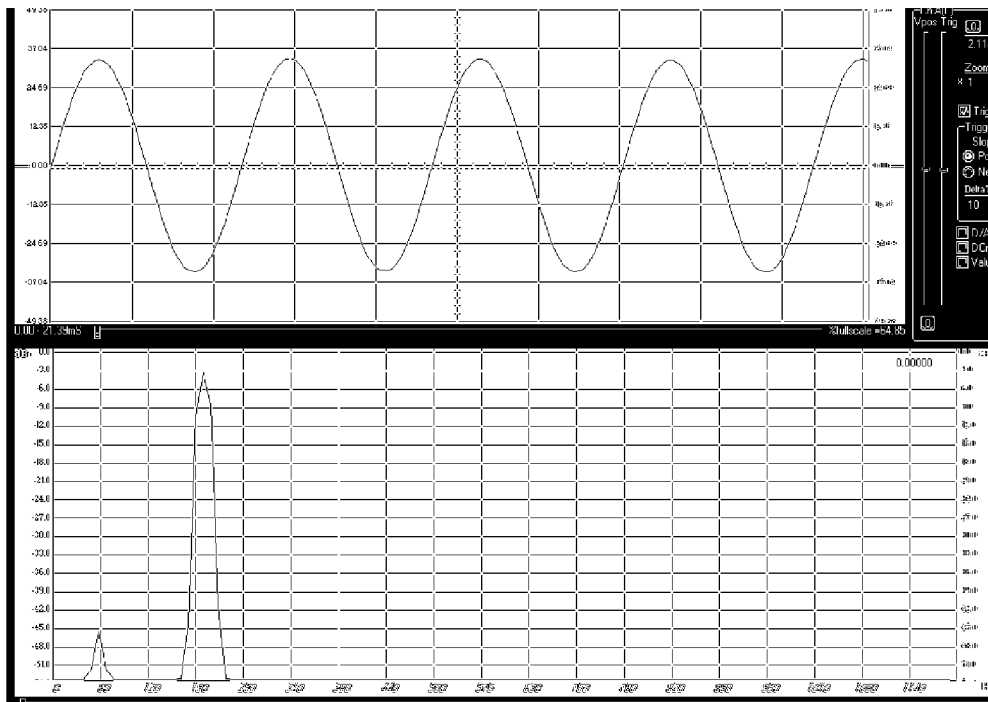


Figure 33a 200 Hz; 10 Megohm Source; Sine Wave; No Flame

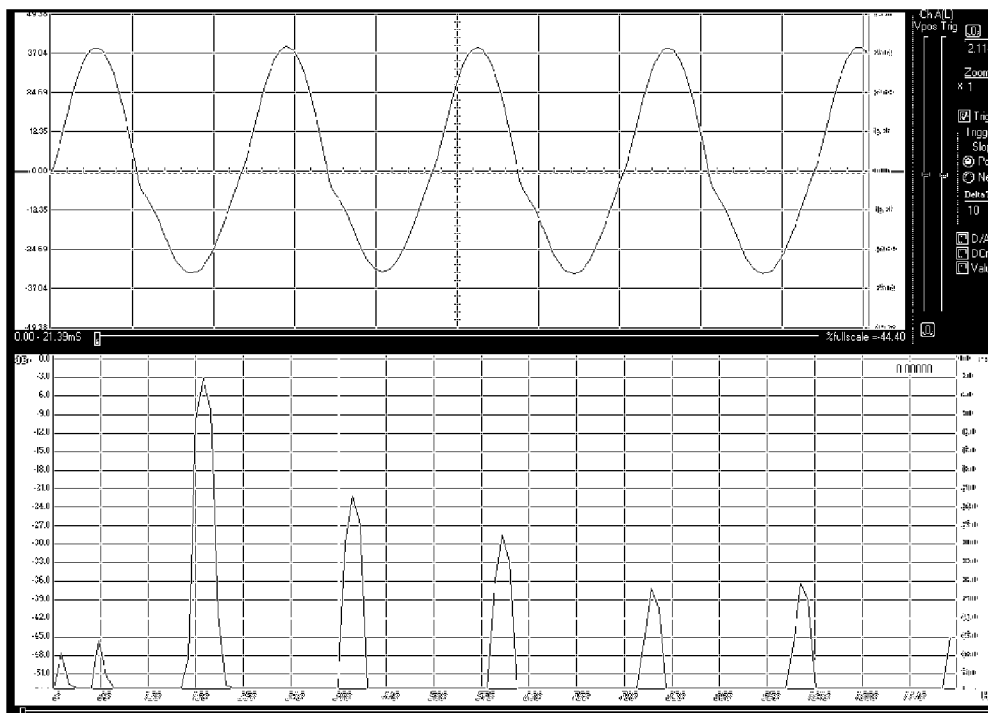


Figure 33b 200 Hz; 10 Megohm Source; Sine Wave; Flame

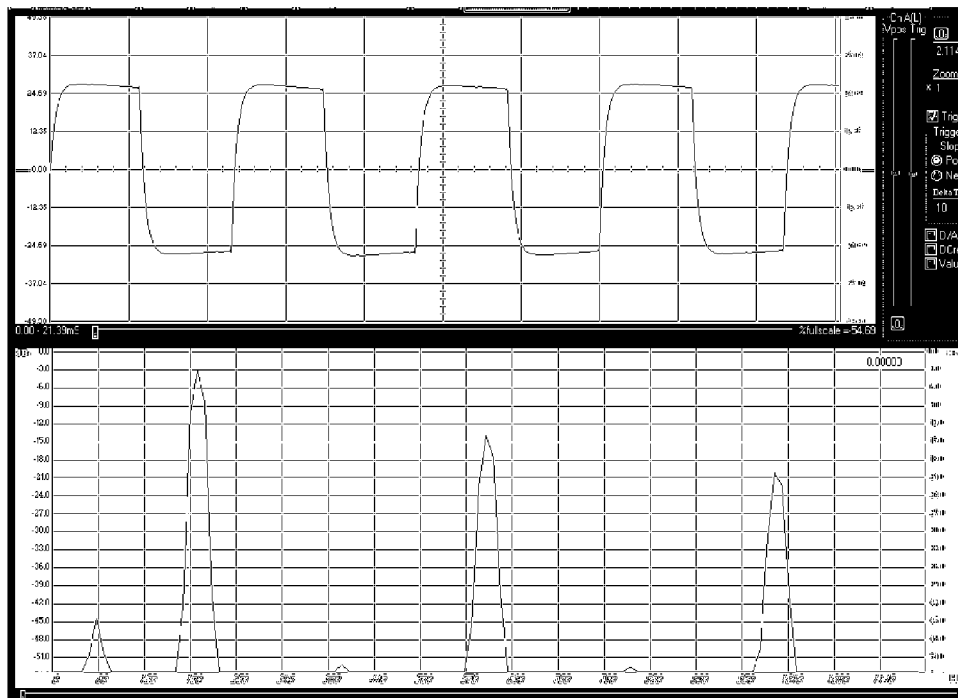


Figure 34a 200 Hz; 10 Megohm Source; Square Wave; No Flame

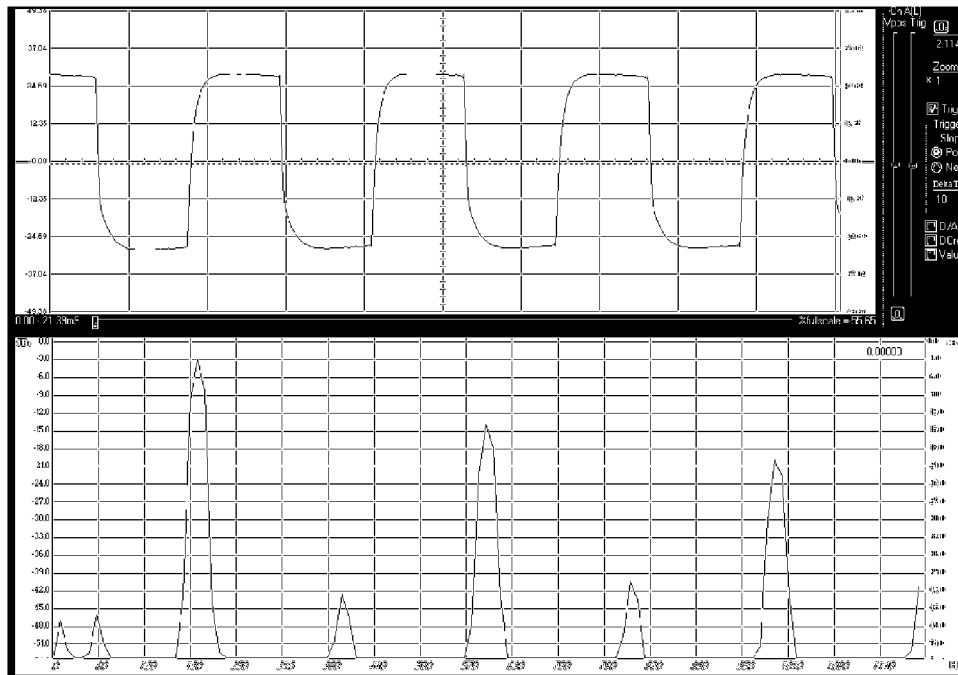


Figure 34b 200 Hz; 10 Megohm Source; Square Wave; Flame

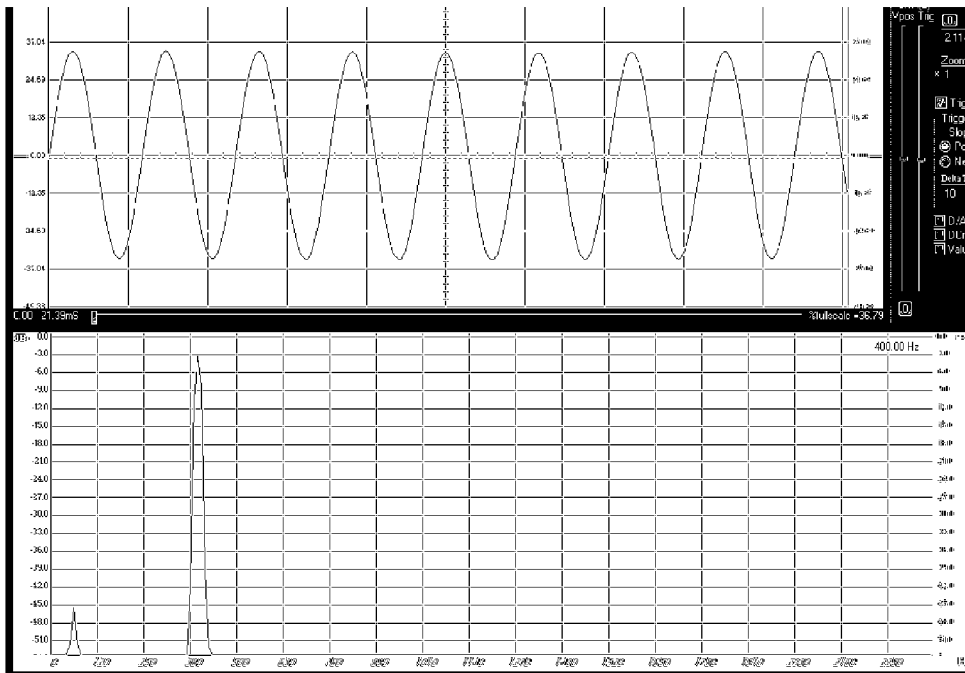


Figure 35a 400 Hz; 10 Megohm Source; Sine Wave; No Flame

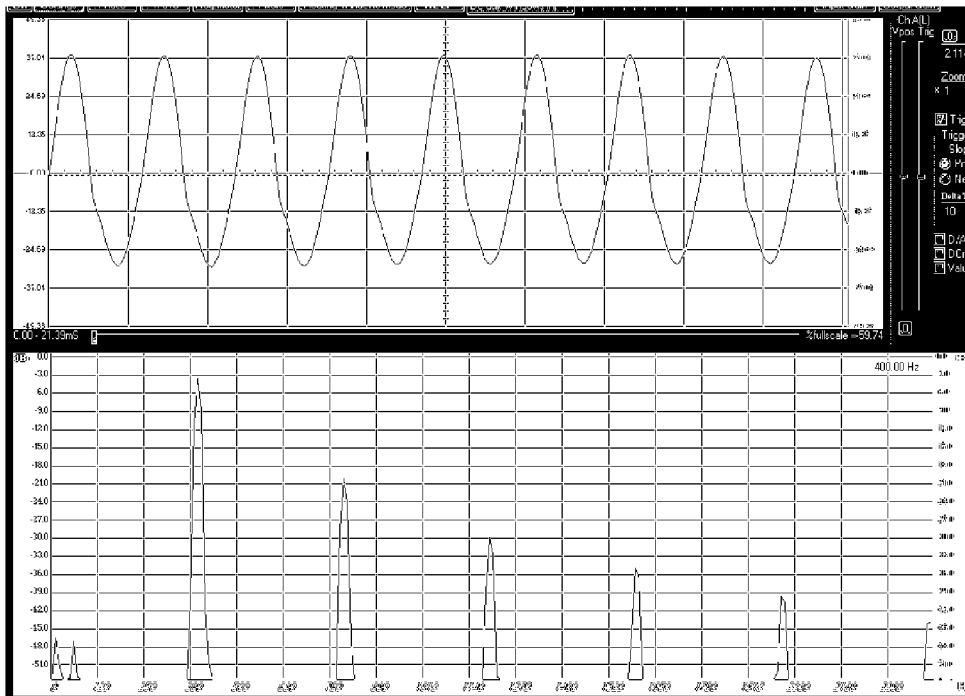


Figure 35b 400 Hz; 10 Megohm Source; Sine Wave; Flame

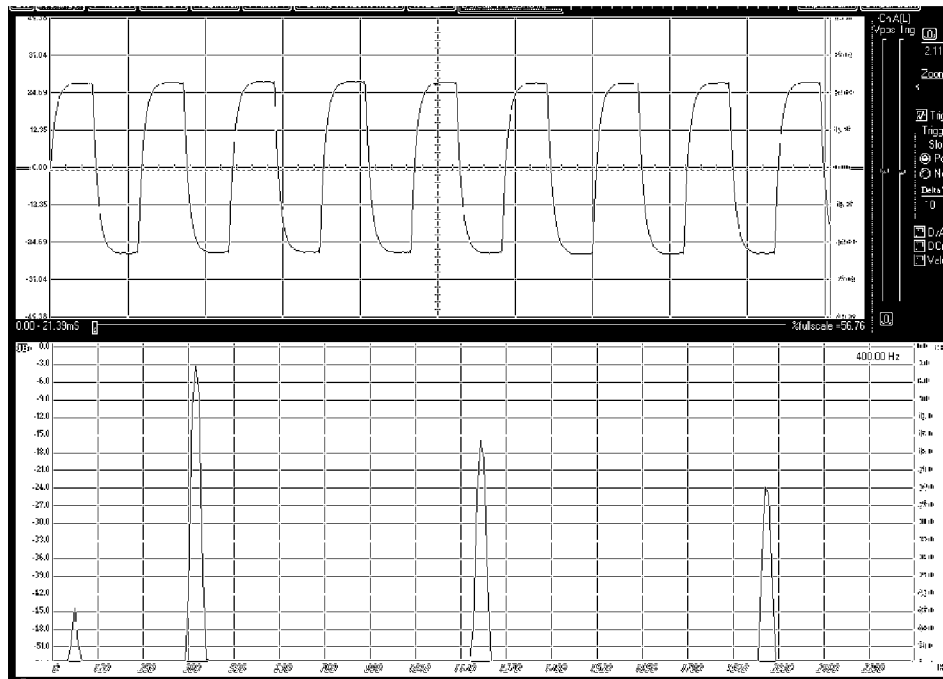


Figure 36a 400 Hz; 10 Megohm Source; Square Wave; No Flame

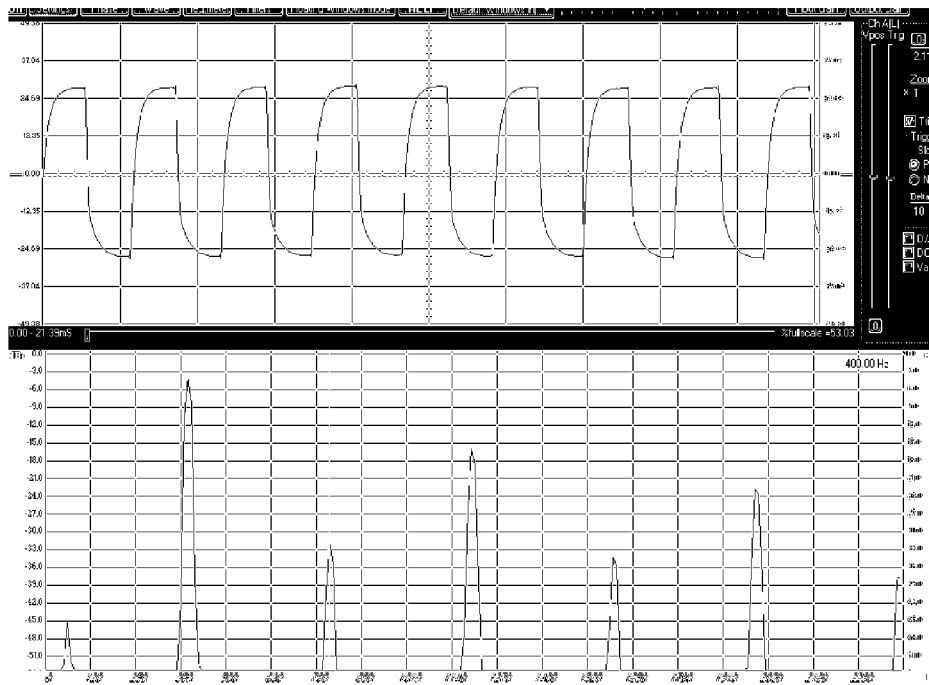


Figure 36b 400 Hz; 10 Megohm Source; Square Wave; Flame

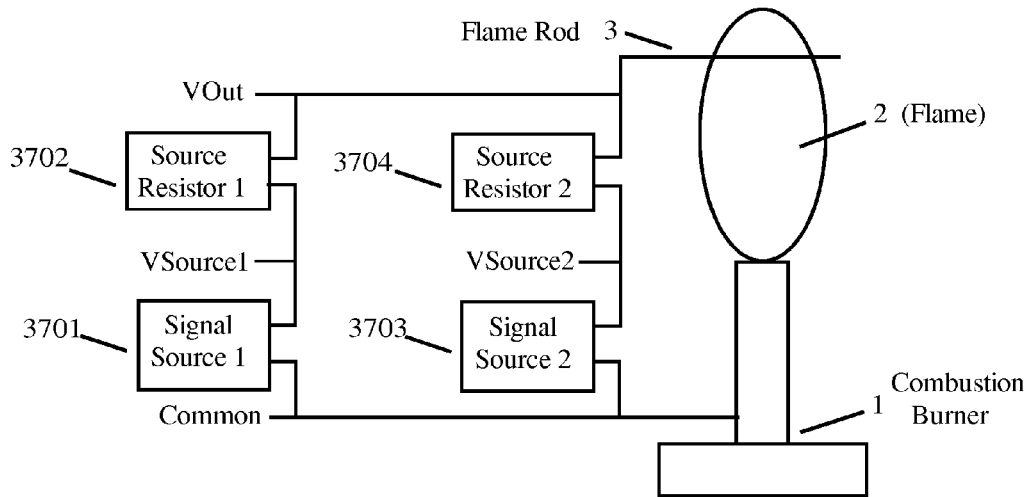


Figure 37

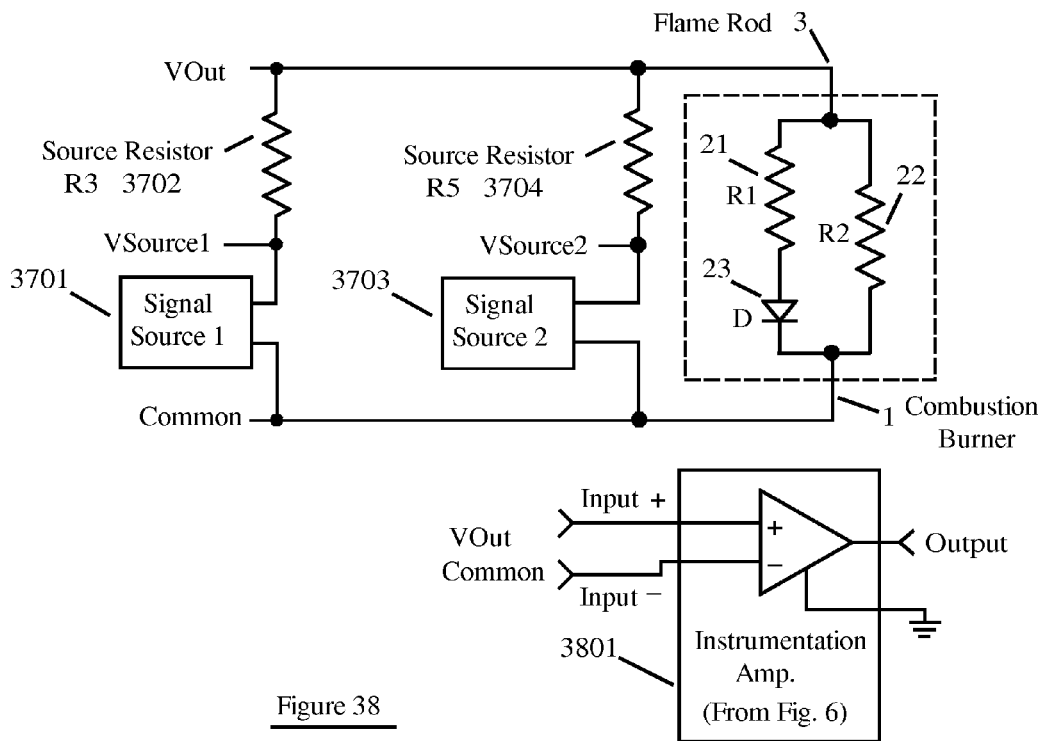


Figure 38

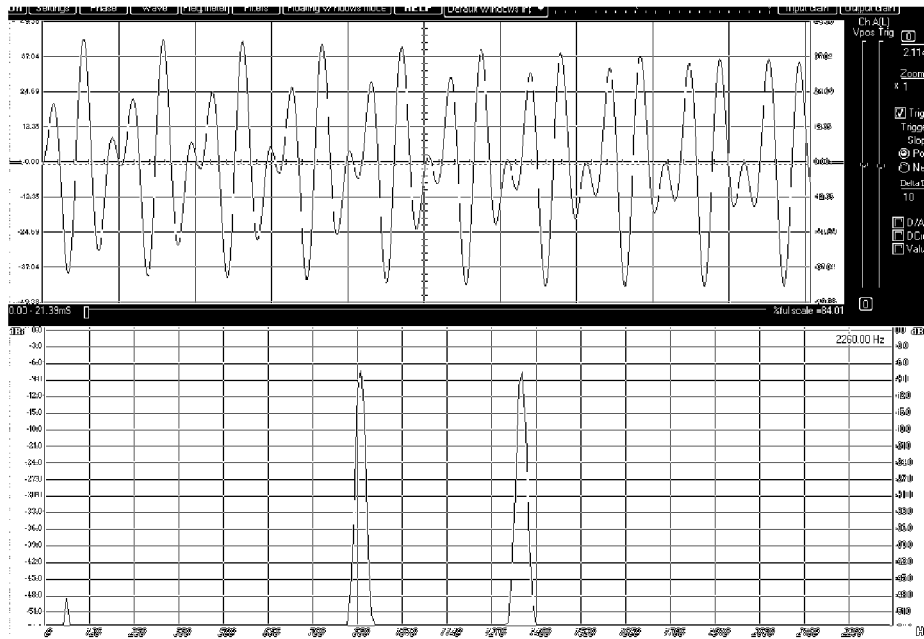
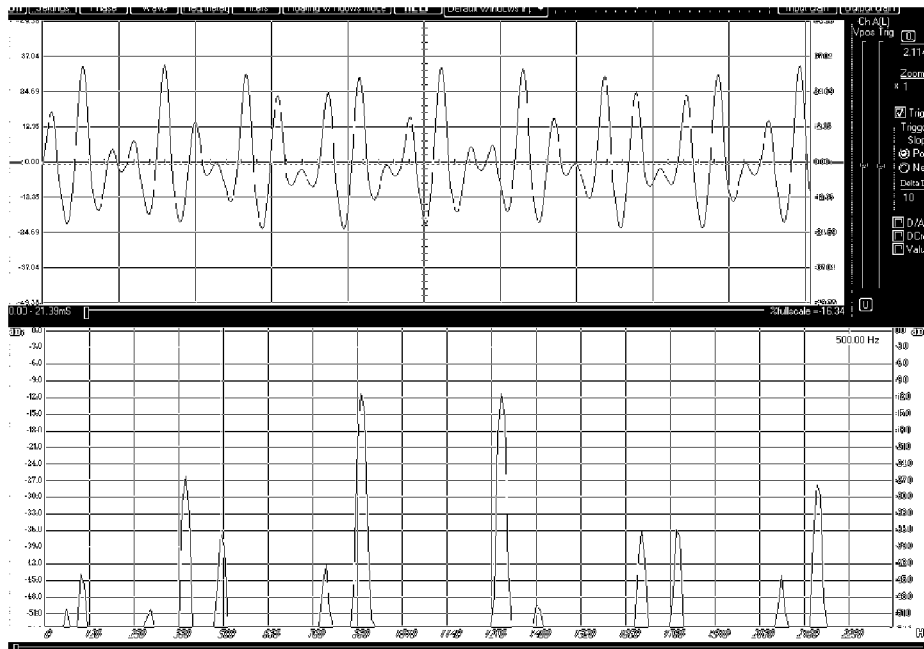
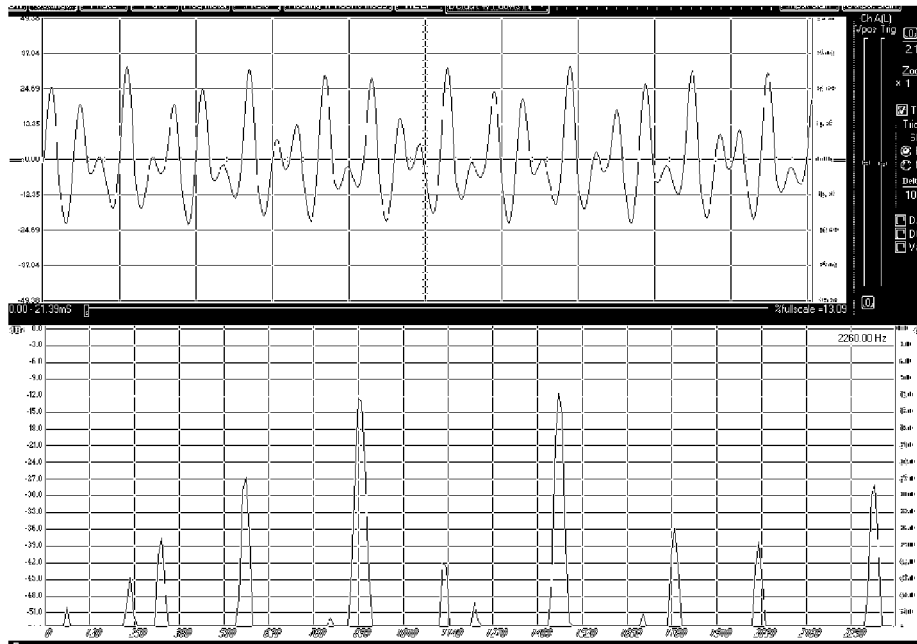


Figure 39a Mixer Test; Sine Waves (No Flame): 900 Hz (-7 dB); 1,300 Hz (-7 dB)



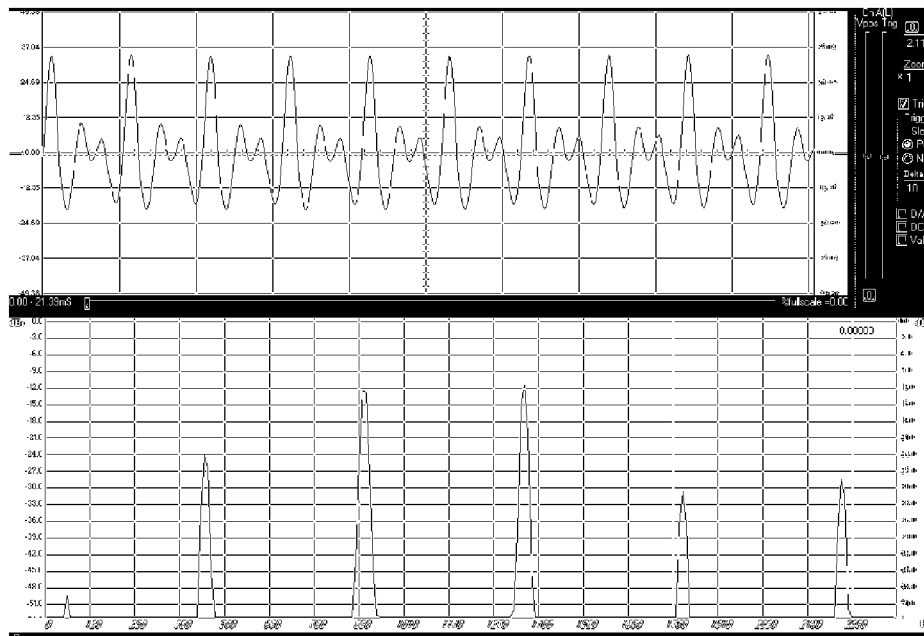
900 Hz (-12 dB); 1,300 Hz (-12 dB); 400 Hz (-27 dB); 2,200 Hz (-27 dB); 500 Hz (-39 dB)

Figure 39b Mixer Test; Sine Waves (Flame):



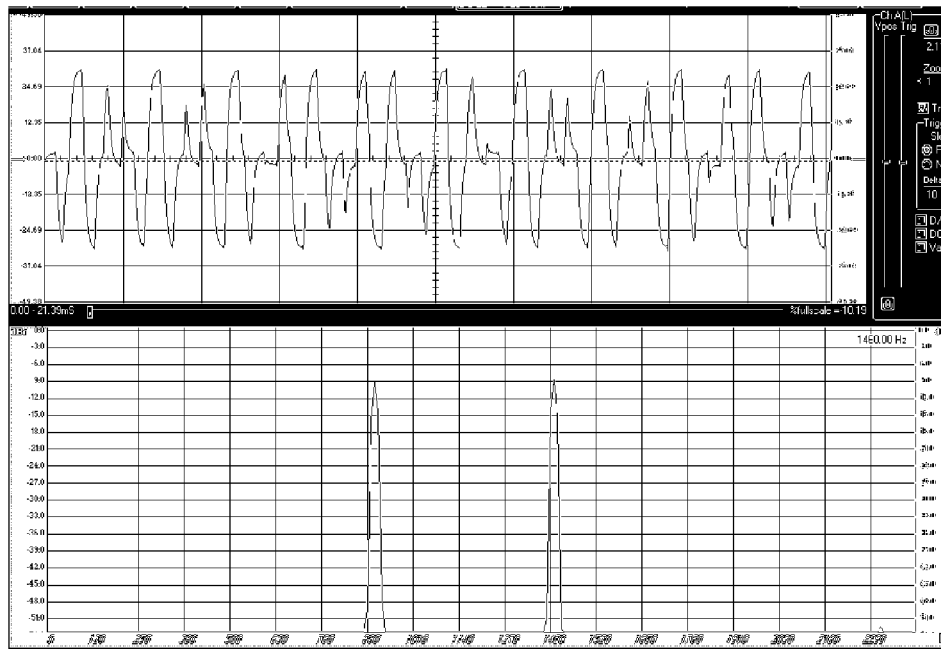
900 Hz (-12dB); 1,460 Hz (-12 dB); 560 Hz (-27 dB); 2,360 Hz (-28 dB); 340 Hz (-37 dB)

Figure 40 Mixer Test; Sine Waves (Flame)



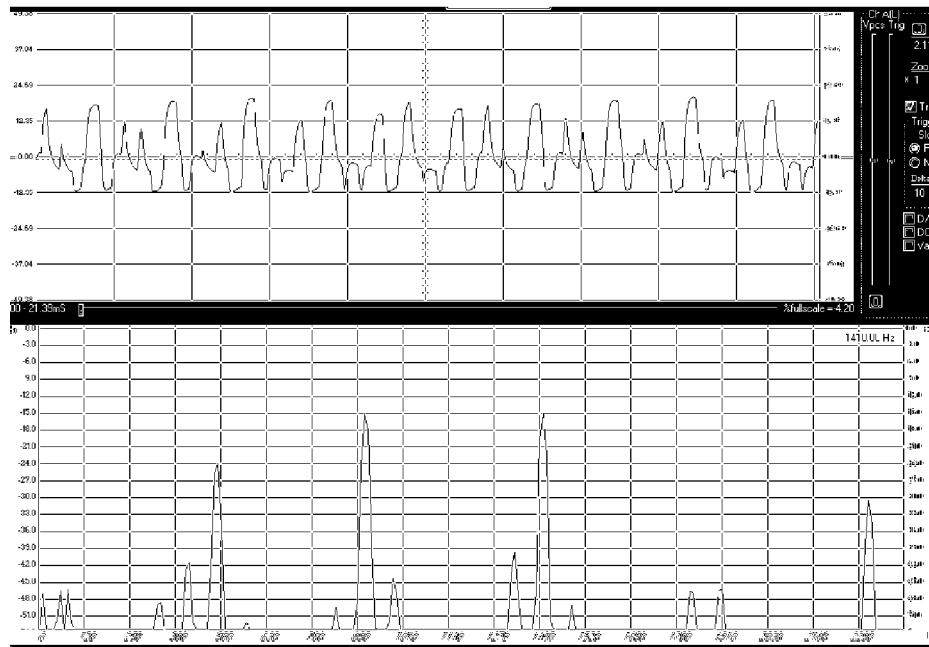
900 Hz (-12dB); 1,350 Hz (-12 dB); 450 Hz (-24 dB); 1,810 Hz (-32 dB); 2,260 Hz (-28 dB)

Figure 41 Mixer Test; Sine Waves (Flame)



910 Hz (-9 dB); 1,410 Hz (-9 dB)

Figure 42a Mixer Test; Square Waves (No Flame)



910 Hz (-15 dB); 1410 Hz (-15 dB); 500 Hz (-24 dB); 2,320 (-30 dB); 410 Hz (-41 dB)

Figure 42b Mixer Test; Square Waves (Flame)

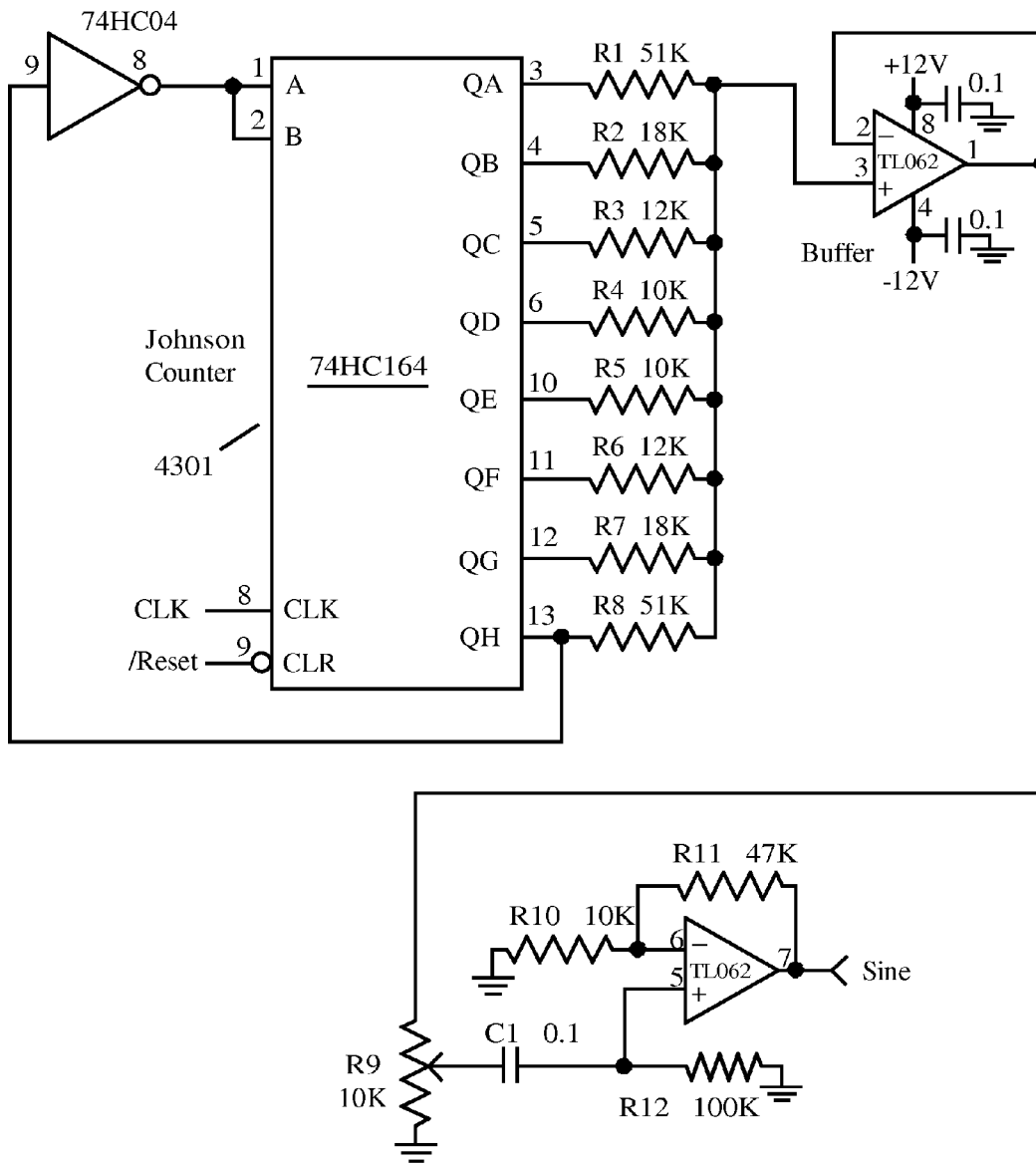


Figure 43a Sine Wave Generator

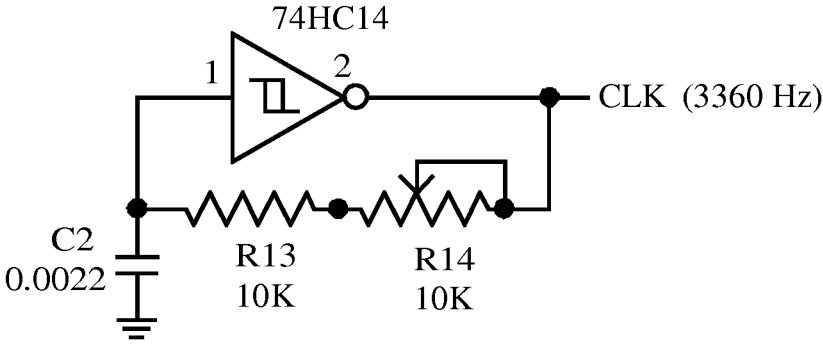


Figure 43b Oscillator

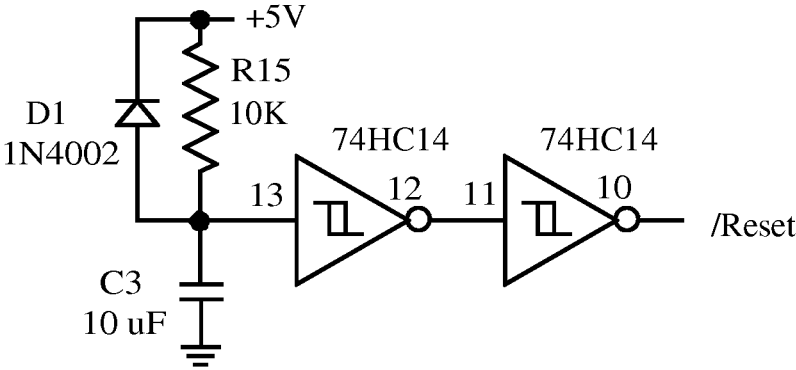
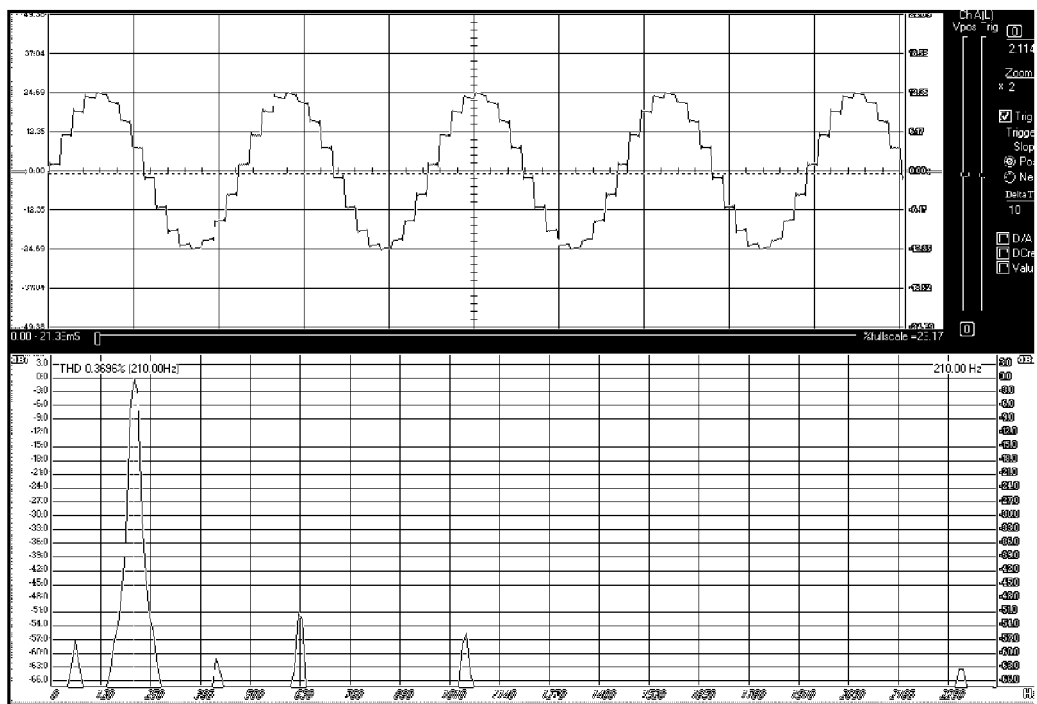
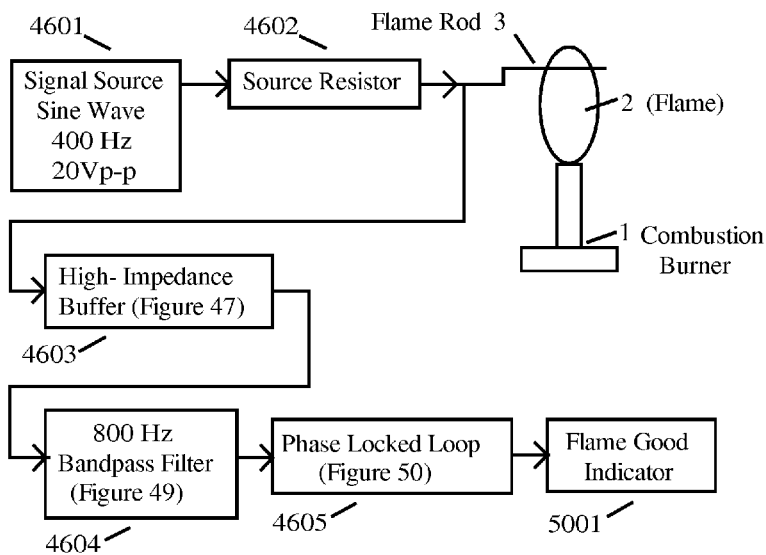
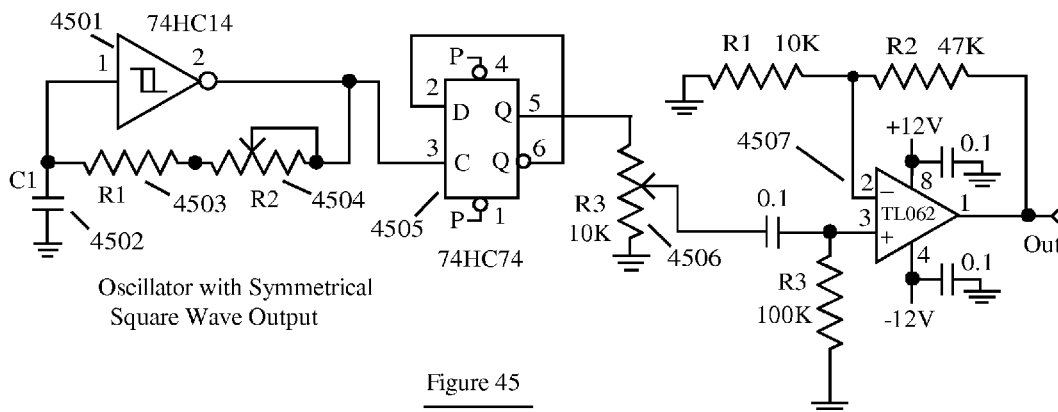


Figure 43c Reset



210 Hz Fundamental 0 dB; 2nd Harmonic -61 dB; 3rd Harmonic -51 dB;
5th Harmonic -54 dB; 60 Hz -57 dB

Figure 44 - Johnson Counter Results



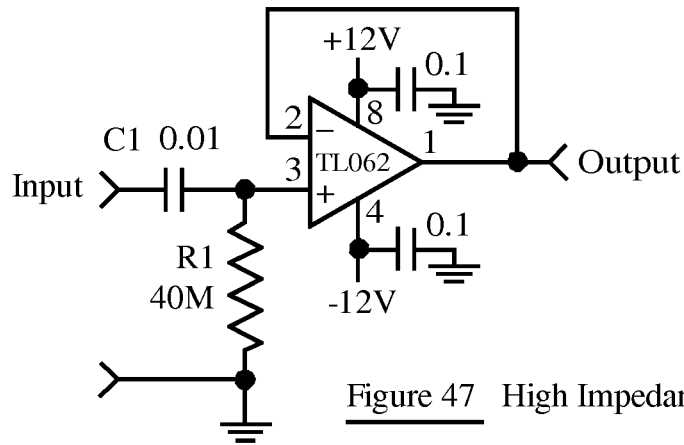


Figure 47 High Impedance Buffer

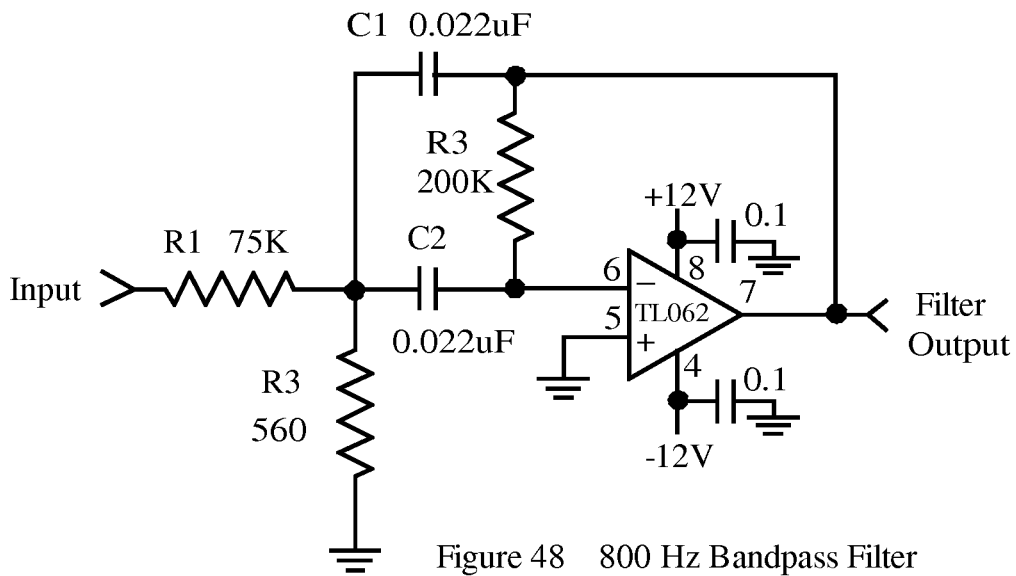


Figure 48 800 Hz Bandpass Filter

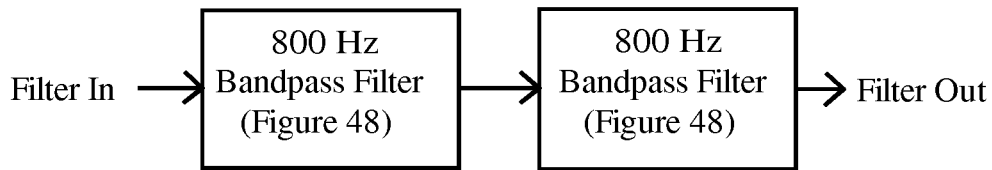


Figure 49 Two Cascaded Bandpass Filters

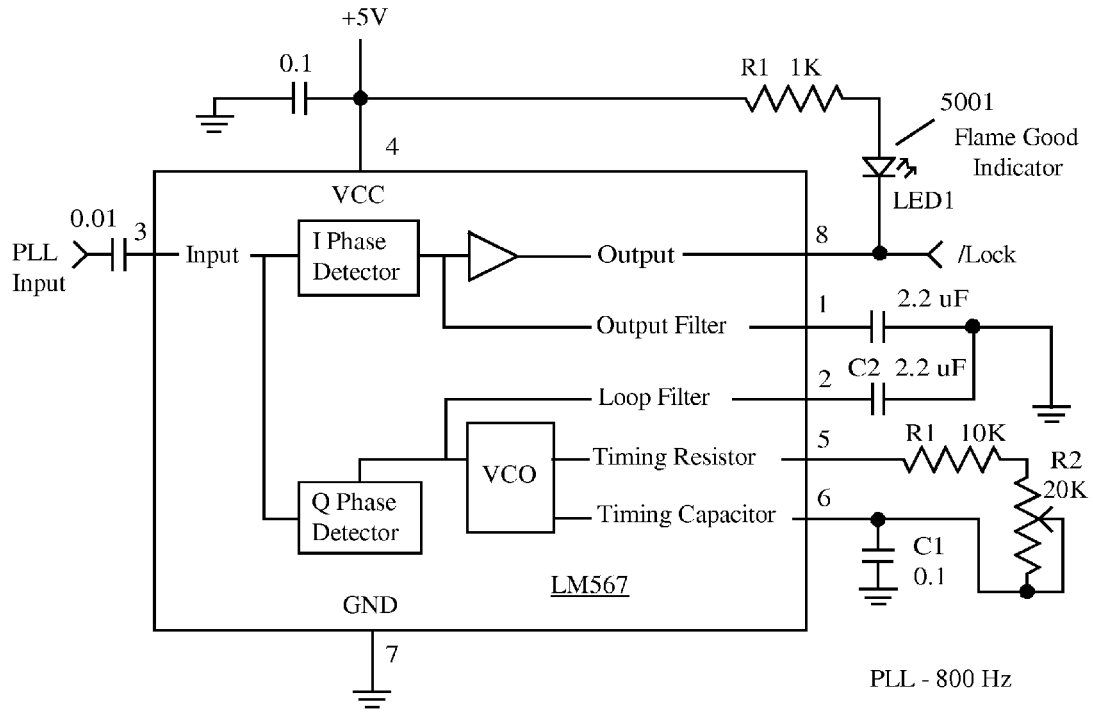


Figure 50

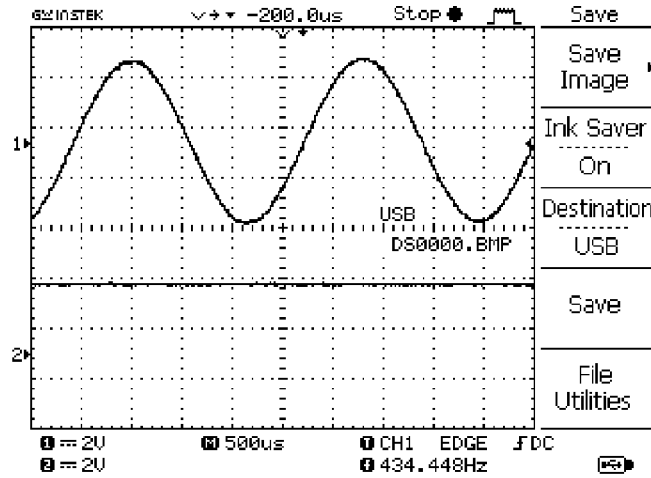


Figure 51a Sine Wave; 435 Hz; Flame Off

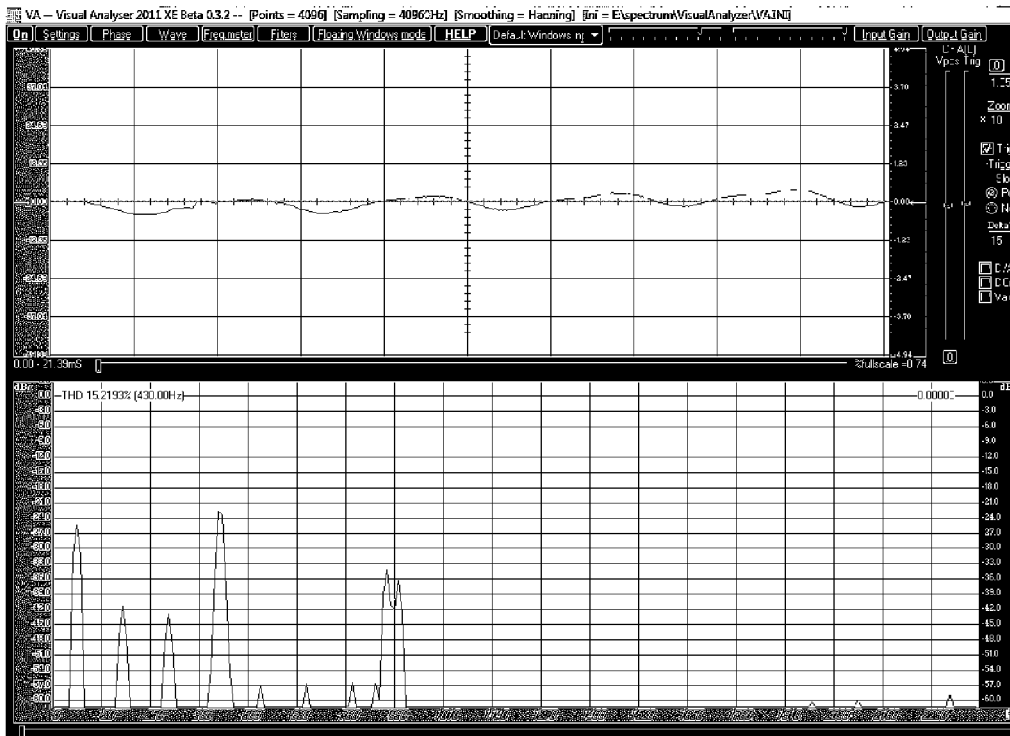


Figure 51b Sine Wave; 435 Hz; Flame Off

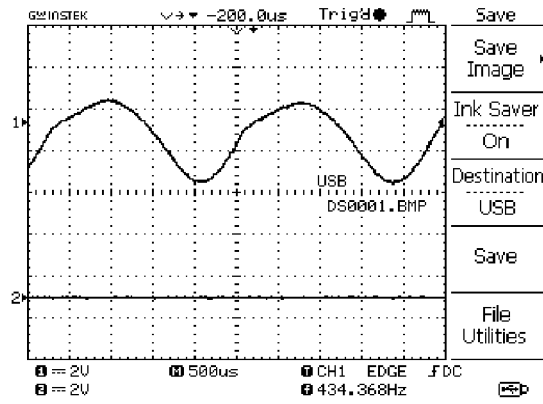


Figure 52a Sine Wave; 435 Hz; Flame On

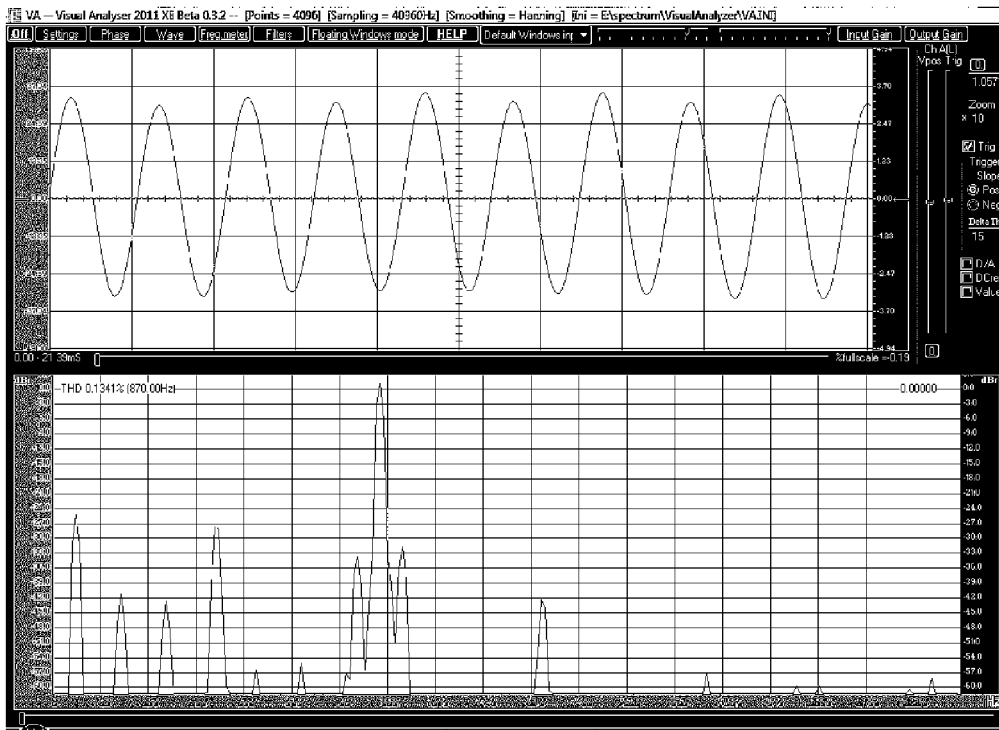


Figure 52b Sine 435 Hz; Flame On

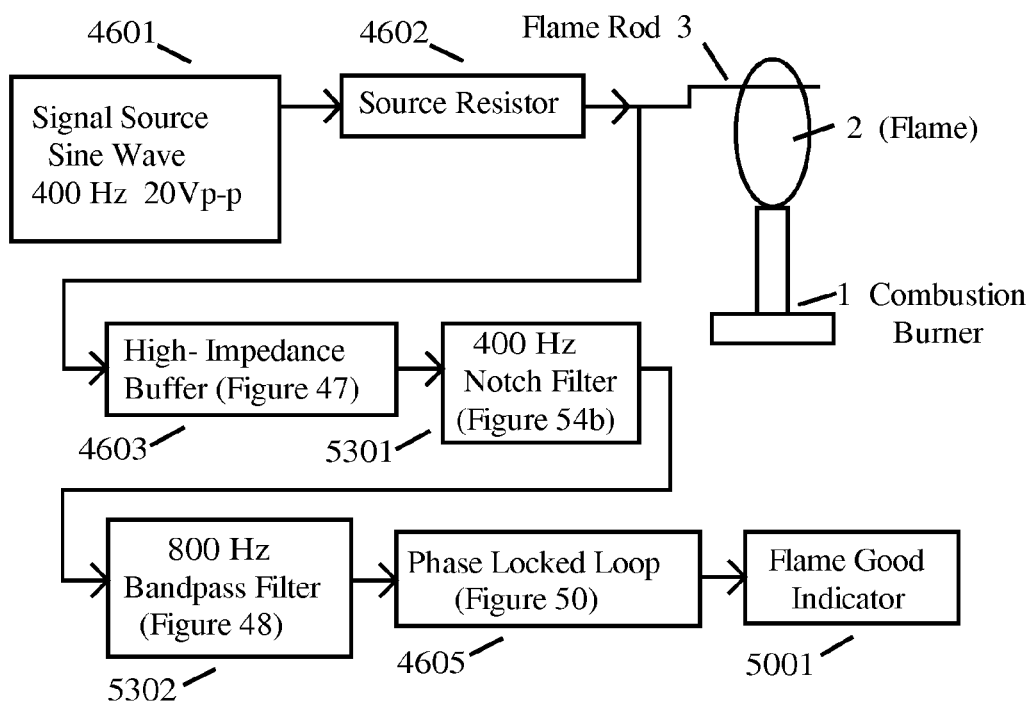


Figure 53

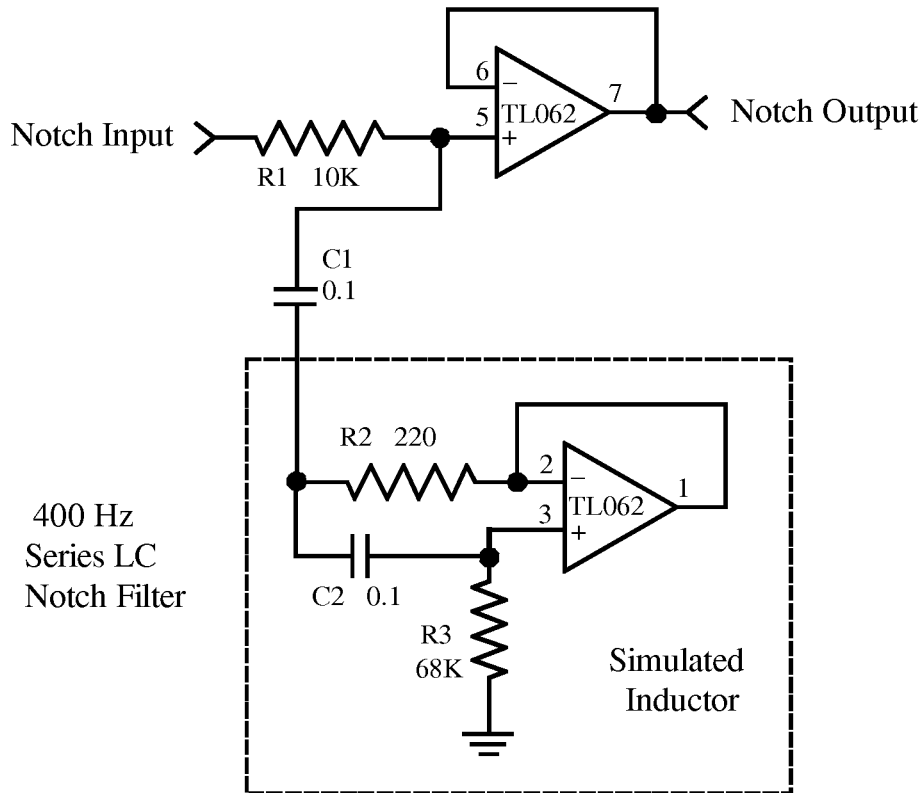
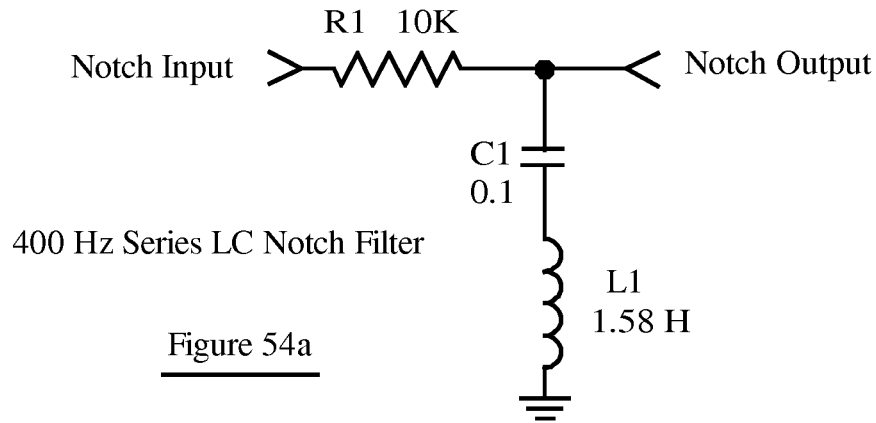


Figure 54b

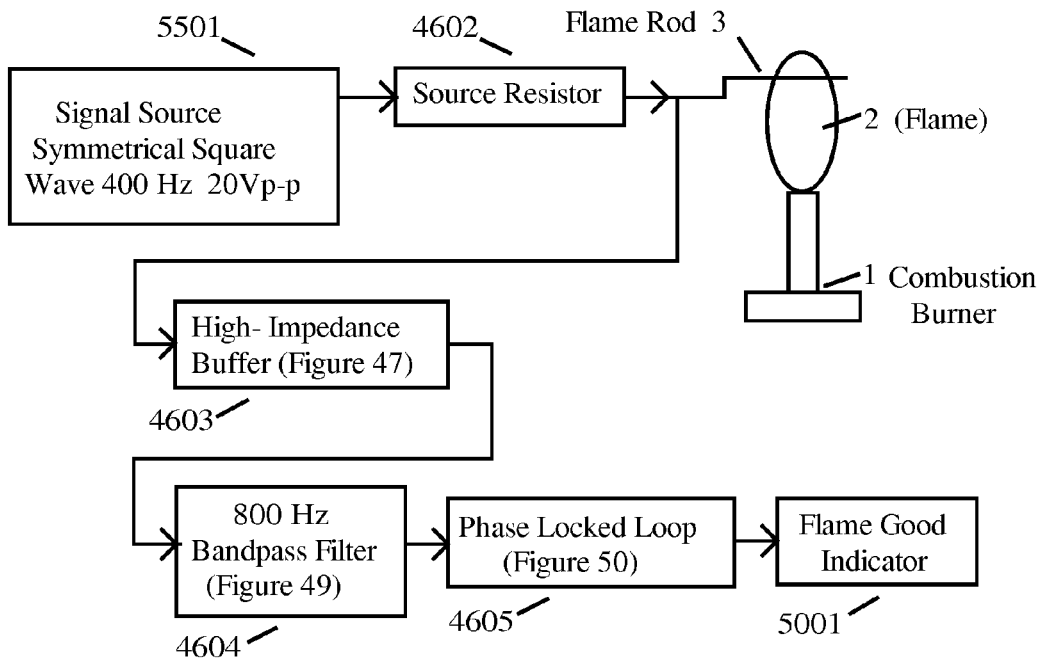


Figure 55

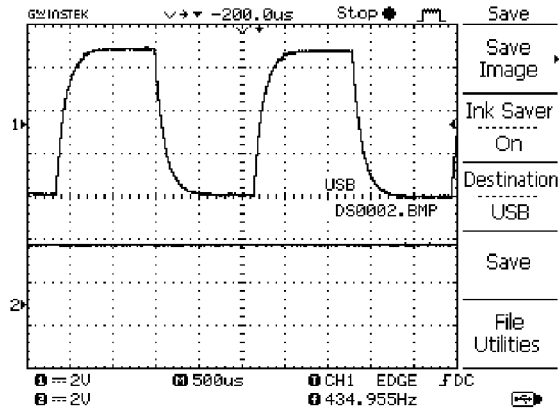


Figure 56a Square Wave; 435 Hz; Flame Off

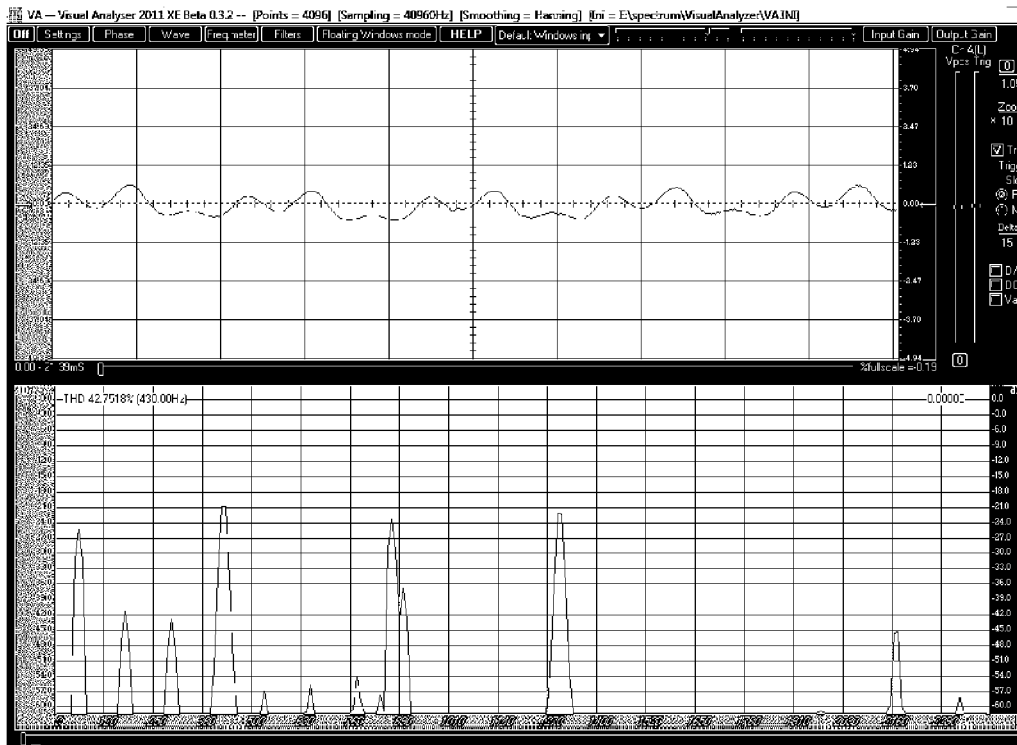


Figure 56b Square Wave; 435 Hz; Flame Off

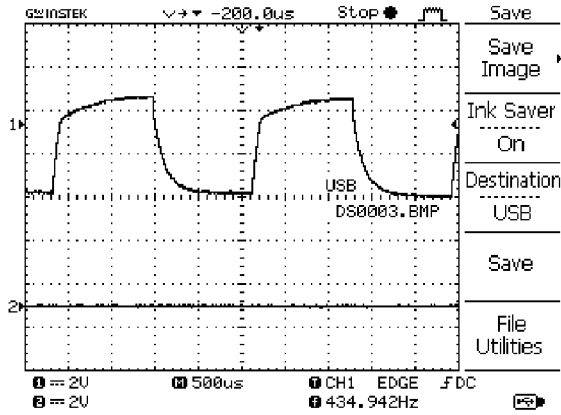


Figure 57a Square Wave; 435 Hz; Flame On

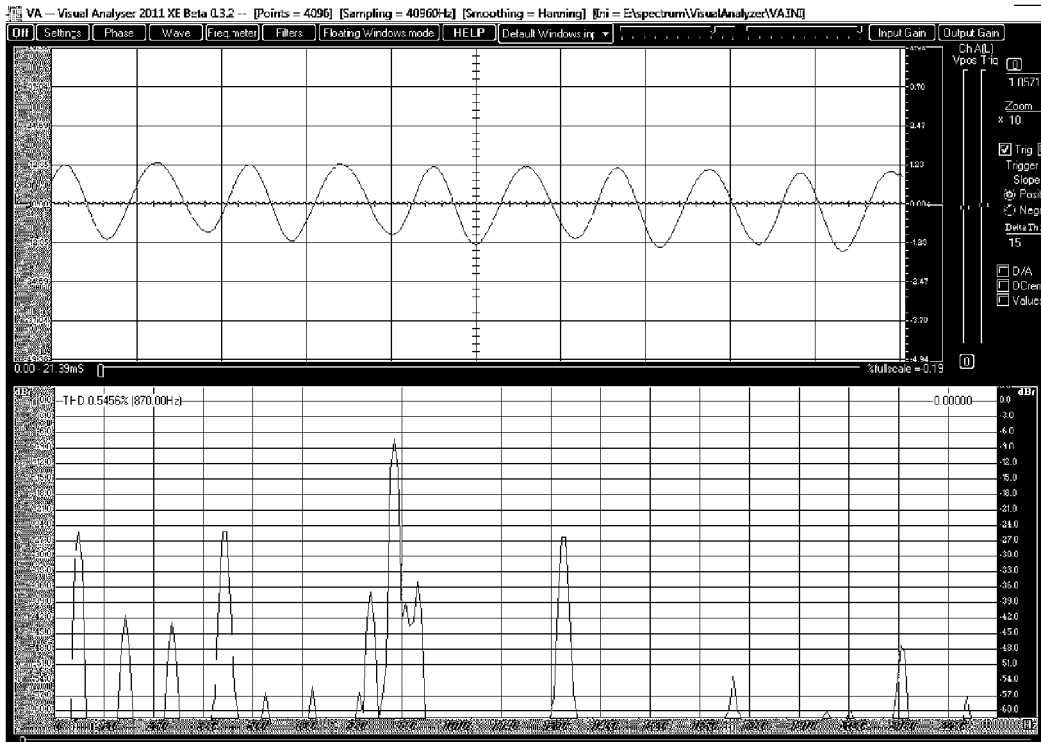


Figure 57b Square Wave; 435 Hz; Flame On

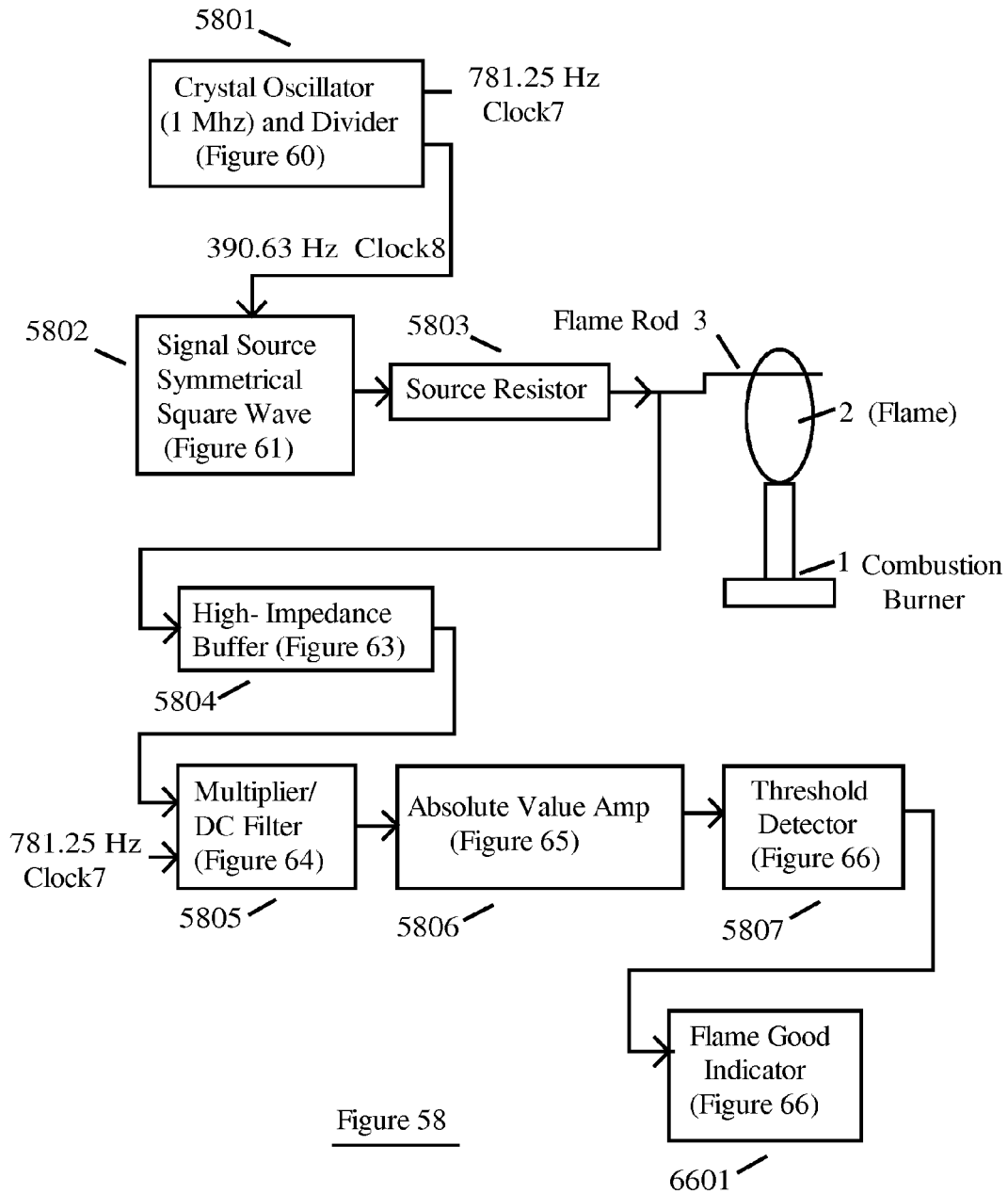


Figure 58

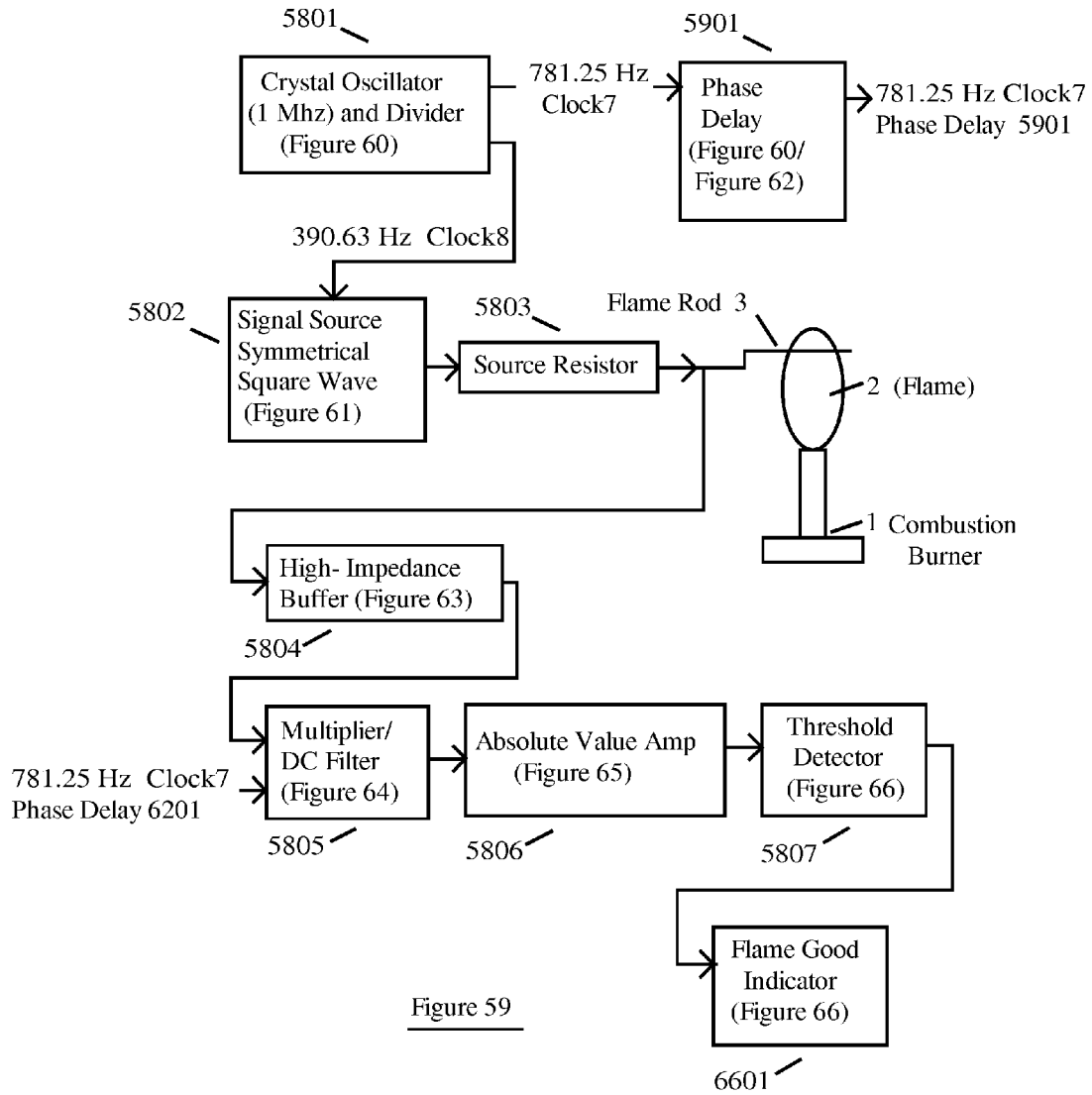


Figure 59

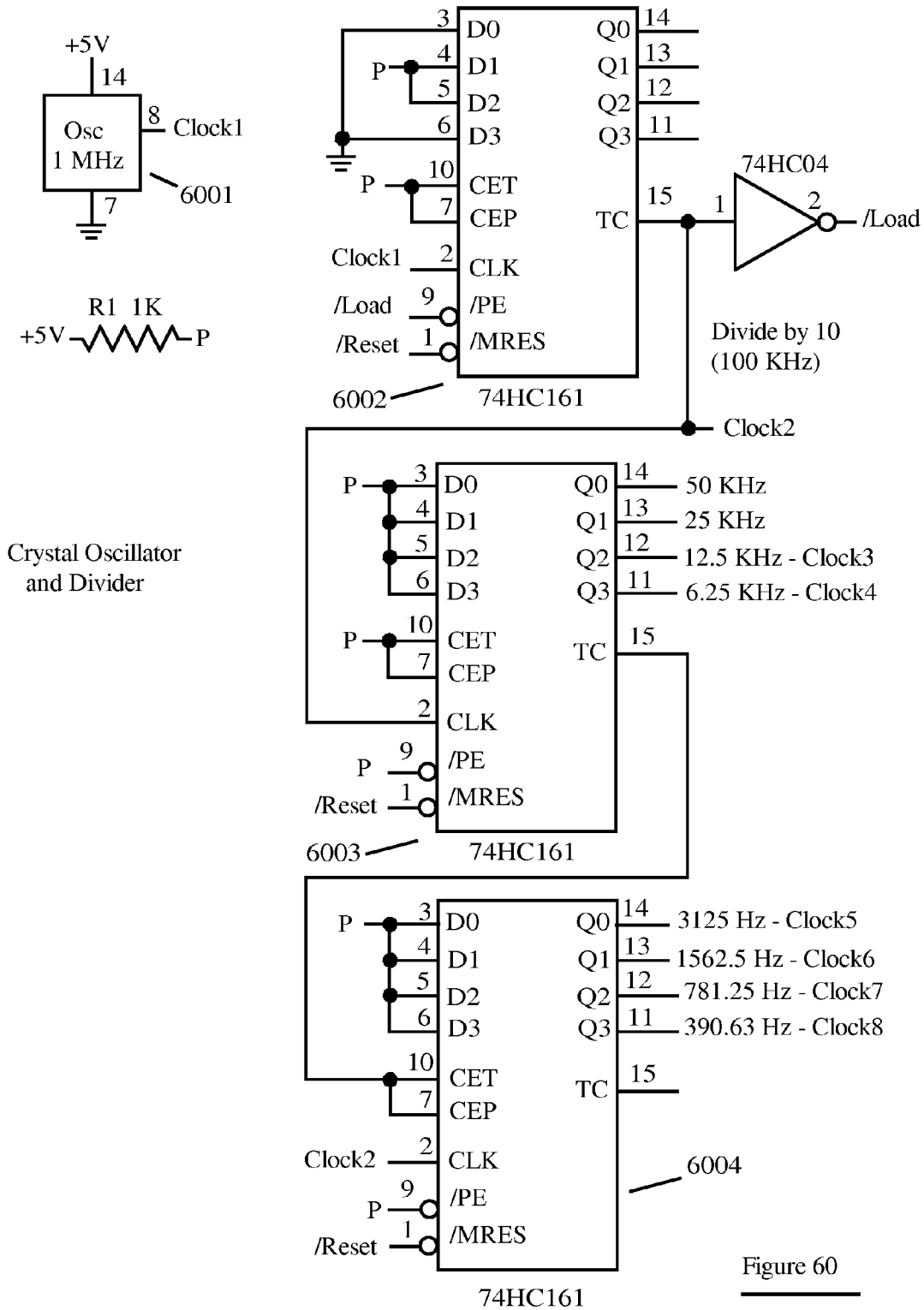


Figure 60

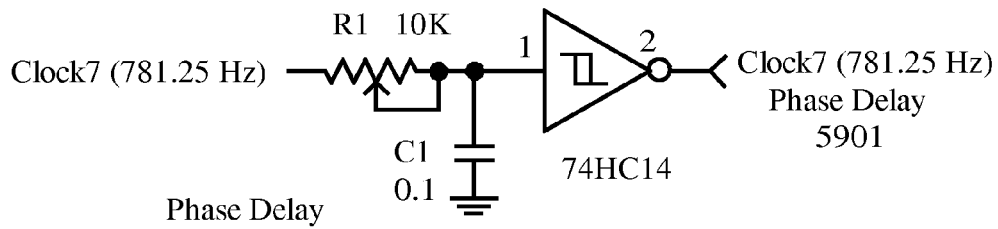
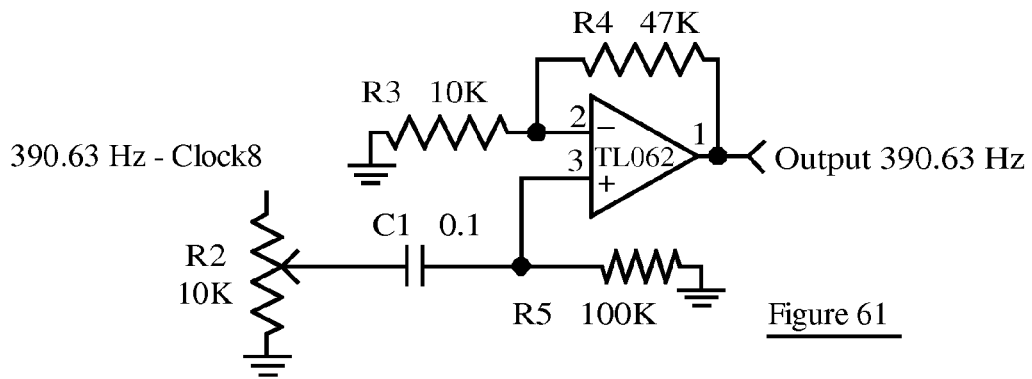


Figure 62

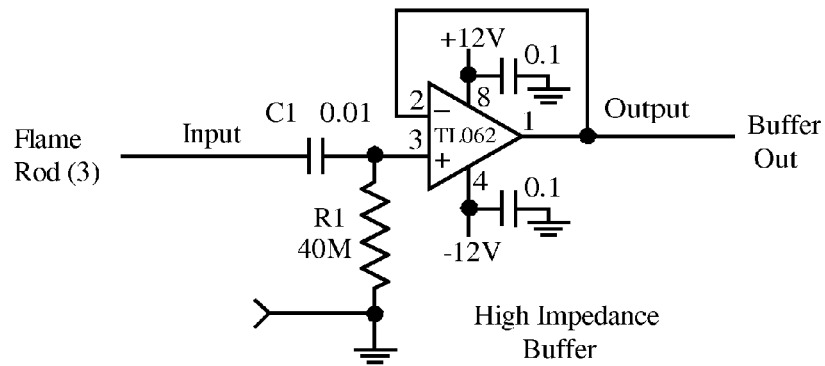


Figure 63

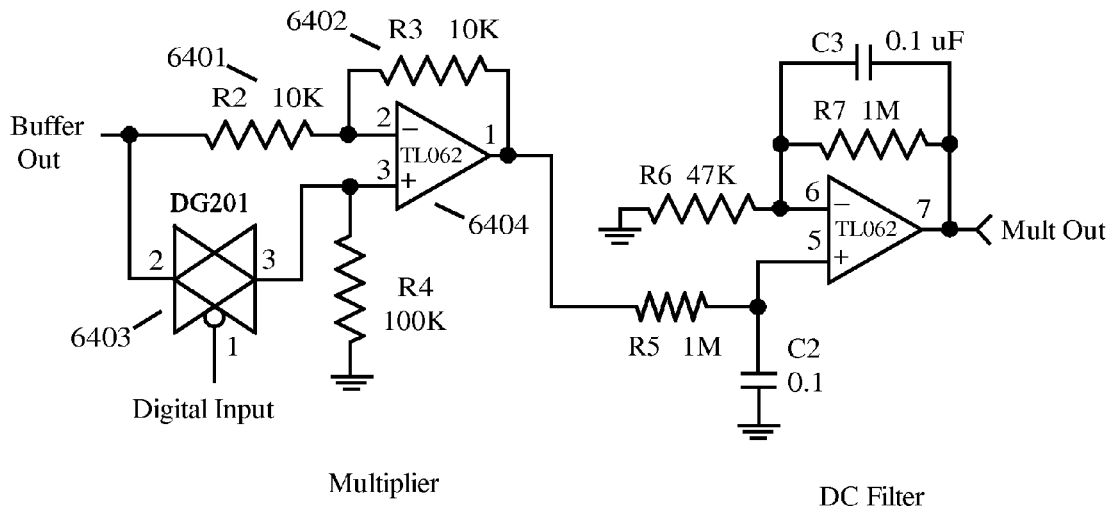


Figure 64

Multiplier and DC Filter

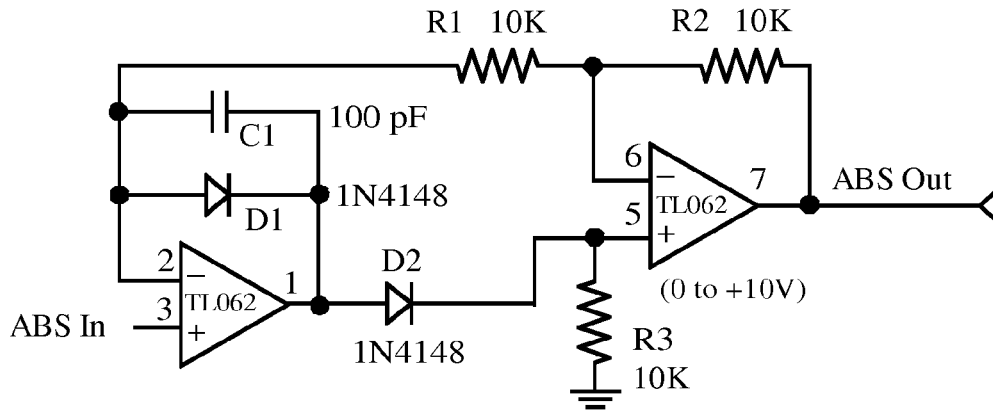


Figure 65 Absolute Value Amp

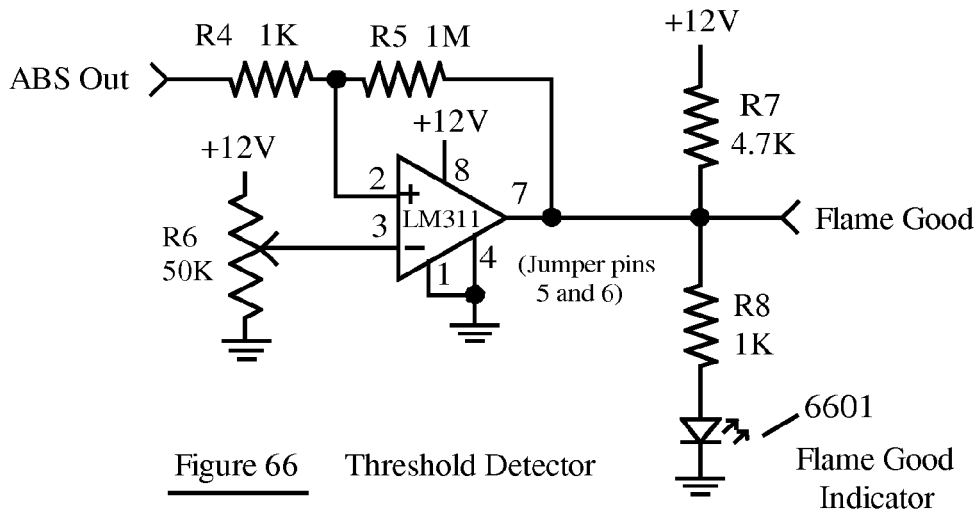


Figure 66 Threshold Detector

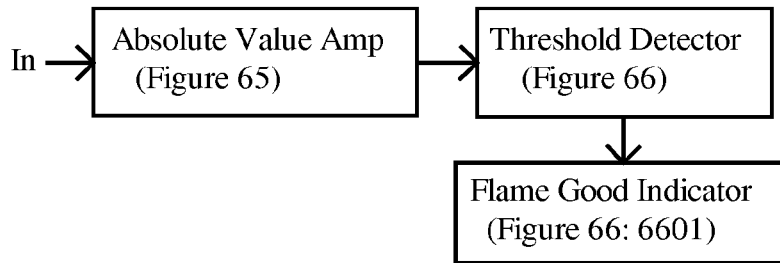
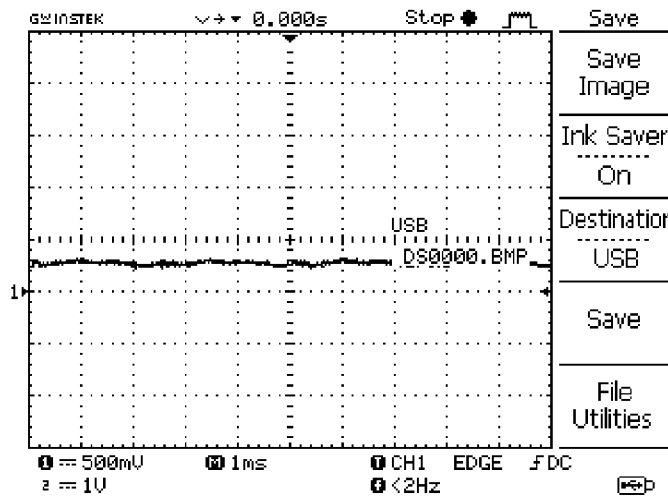
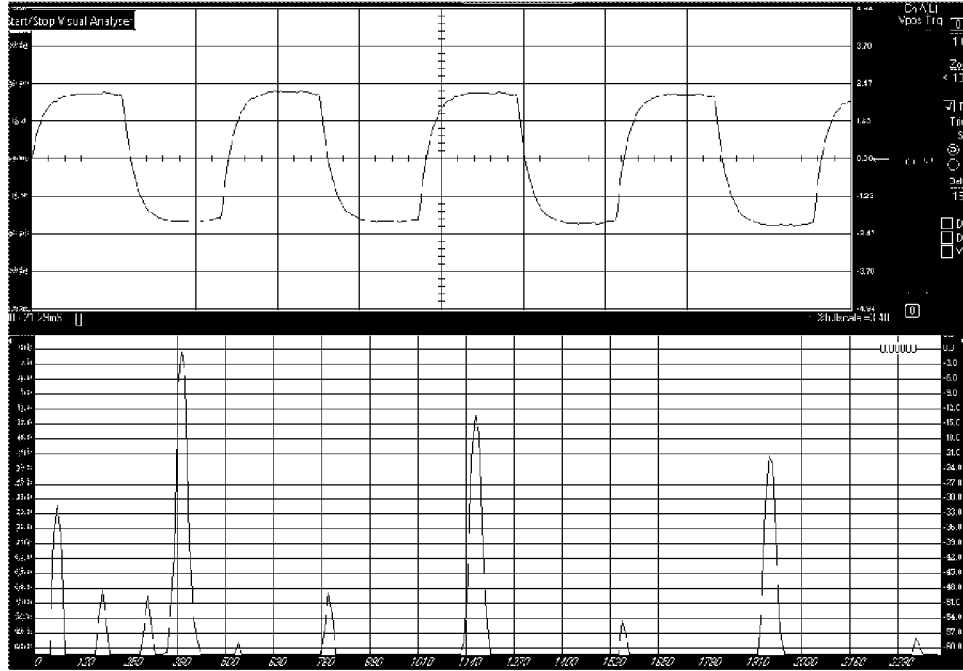
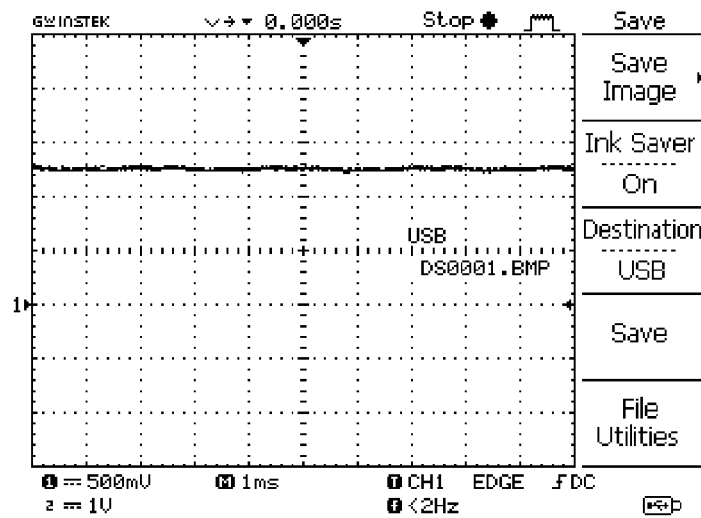
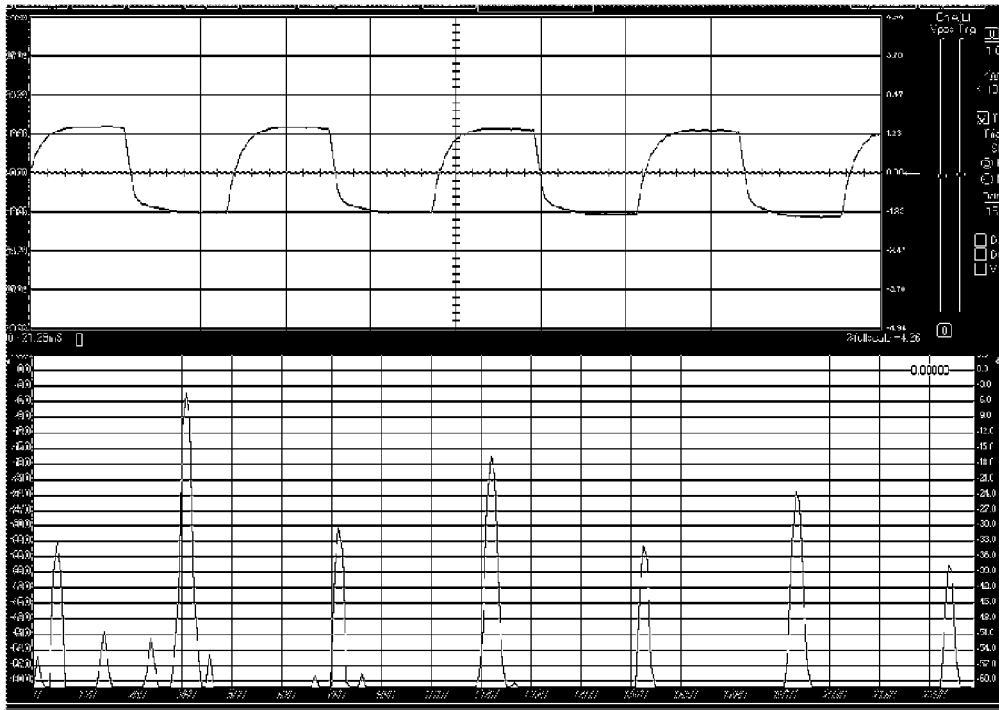


Figure 67 Threshold Detector



Experiment 14 Detecting a harmonic signal produced by flame rectification;
Signal Source: Symmetrical Square Wave
Detector: Simple Synchronous Detector
Flame: Off

Figure 68a



Experiment 14 Detecting a harmonic signal produced by flame rectification;
Signal Source: Symmetrical Square Wave
Detector: Simple Synchronous Detector
Flame: On

Figure 68b

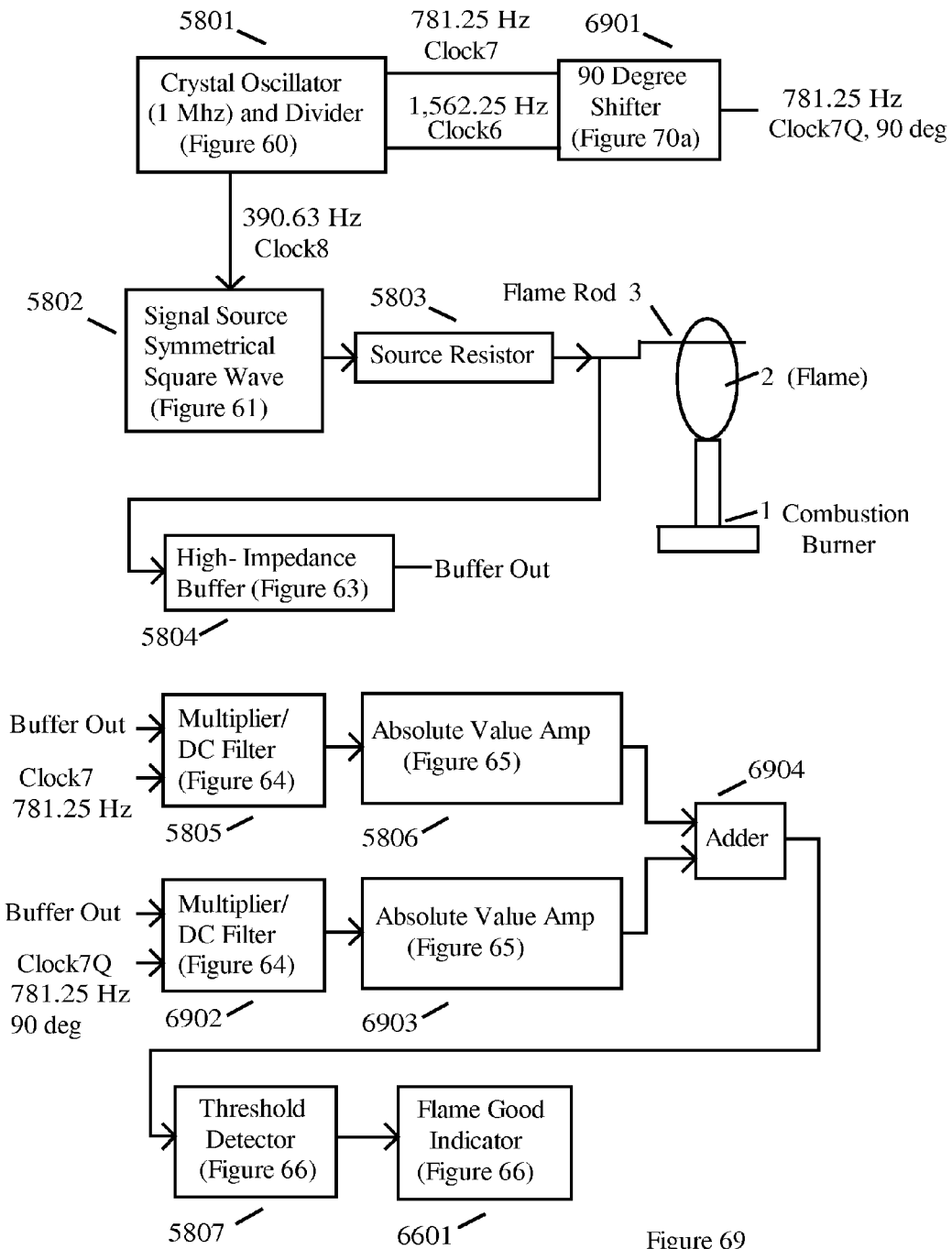


Figure 69

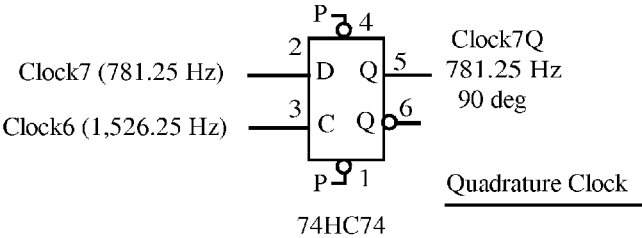


Figure 70a

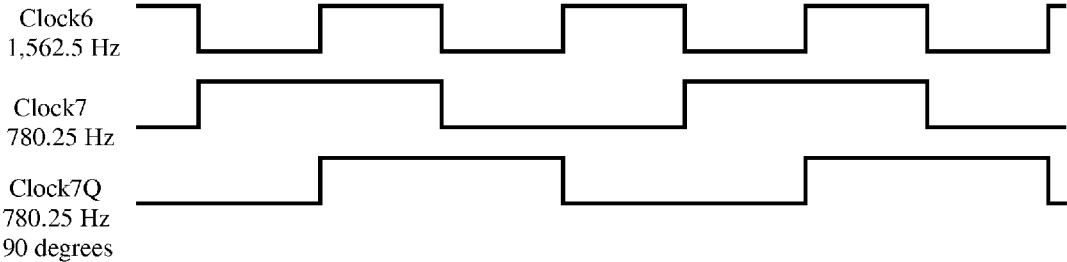


Figure 70b

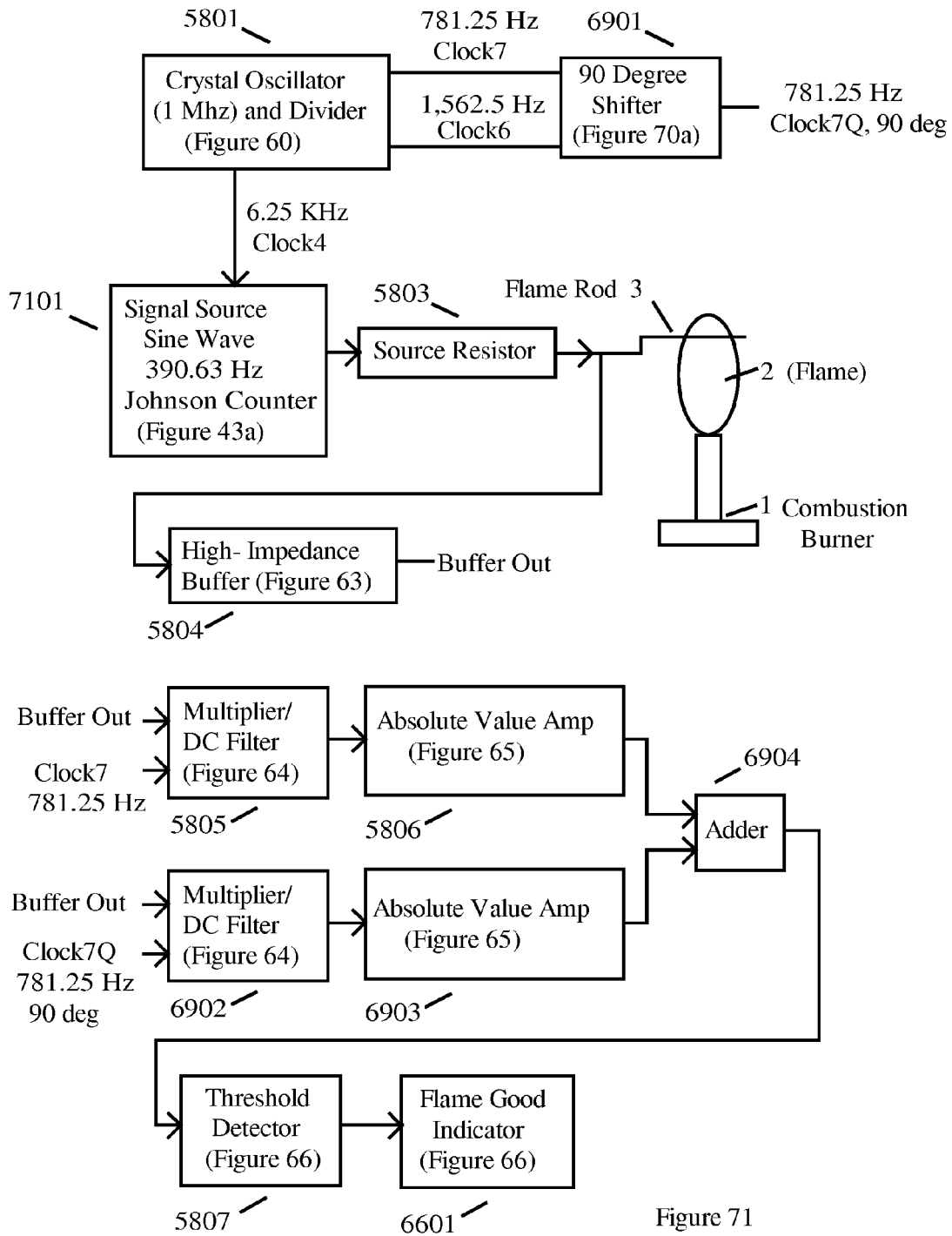


Figure 71

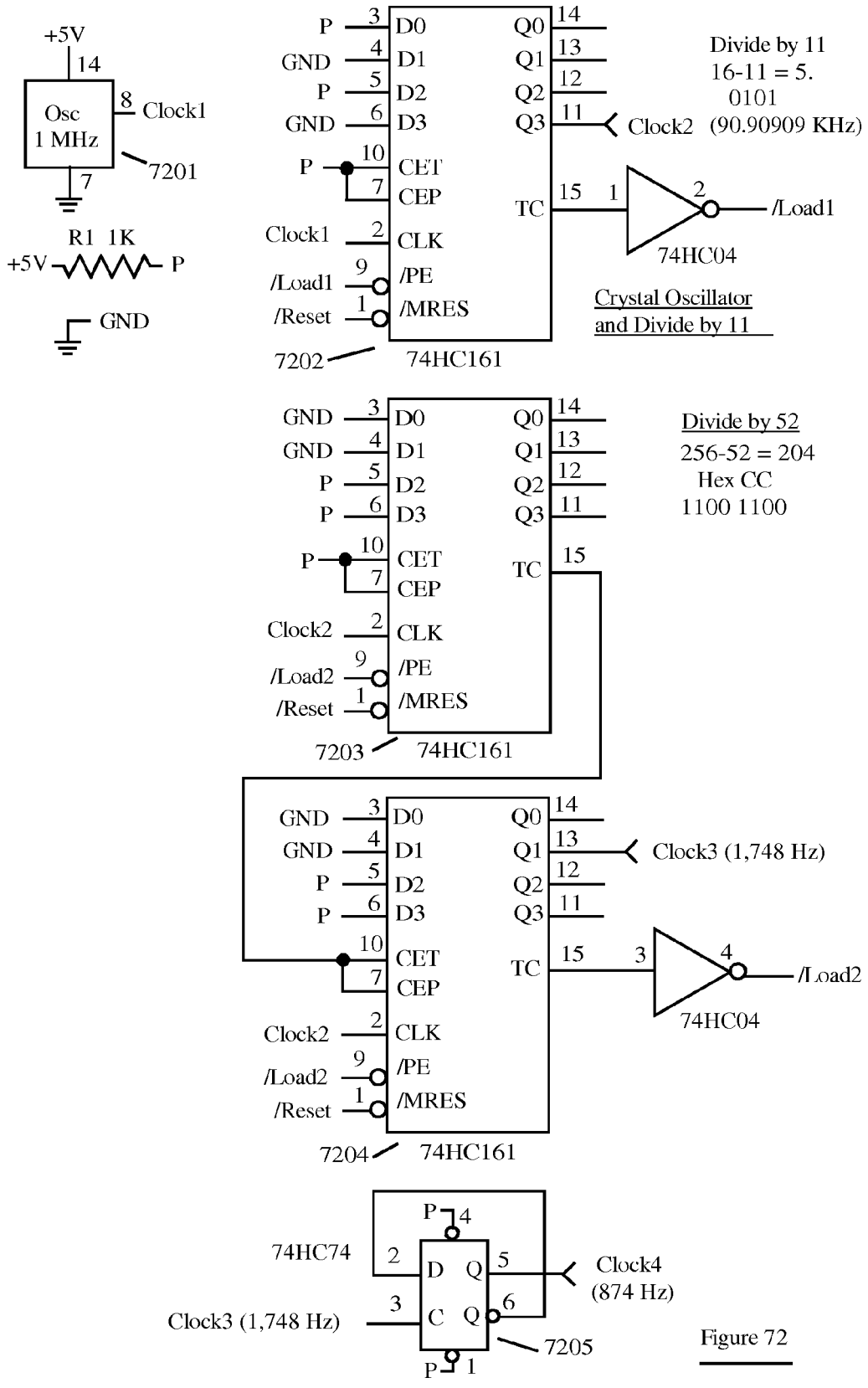
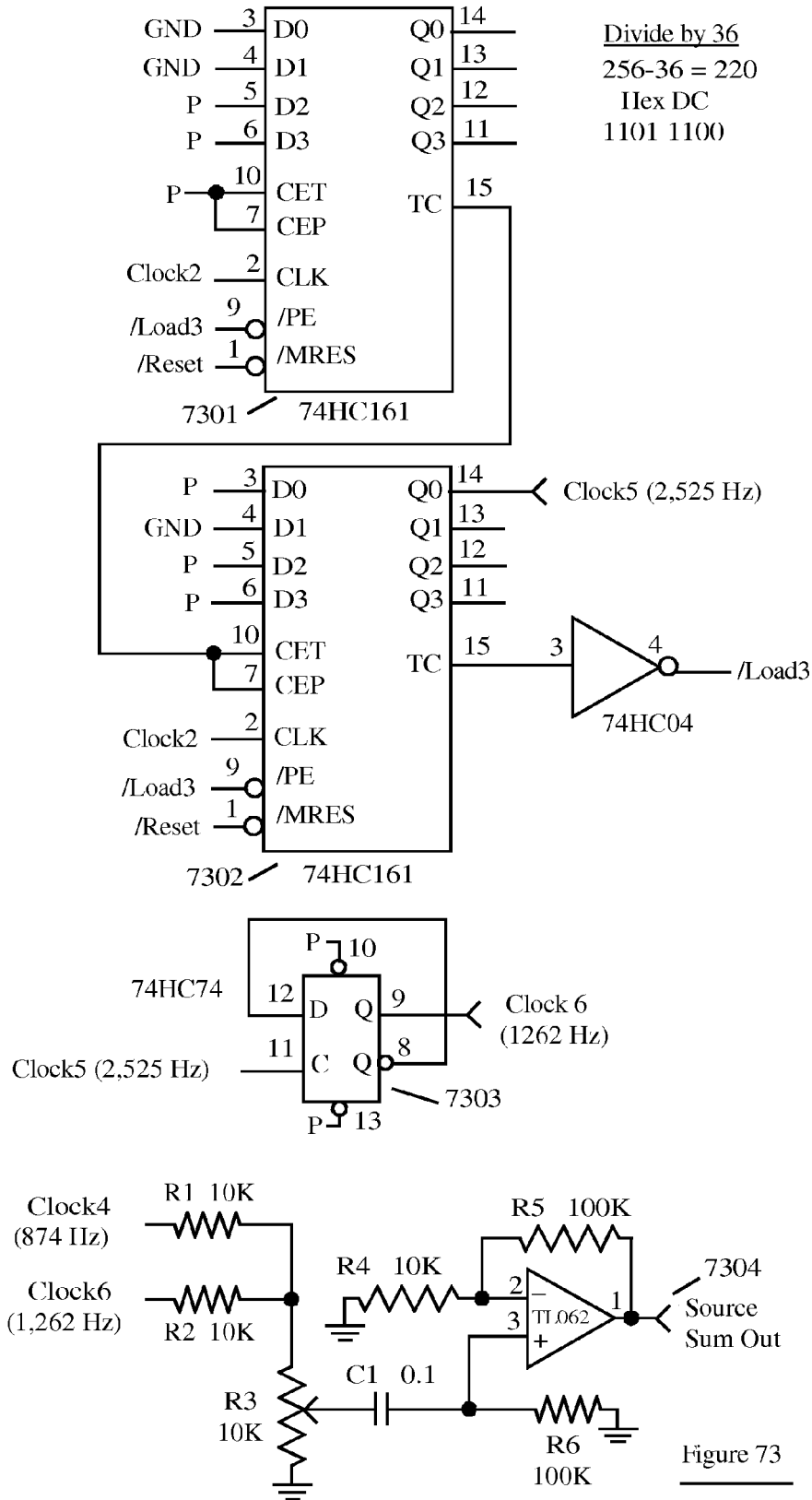


Figure 72



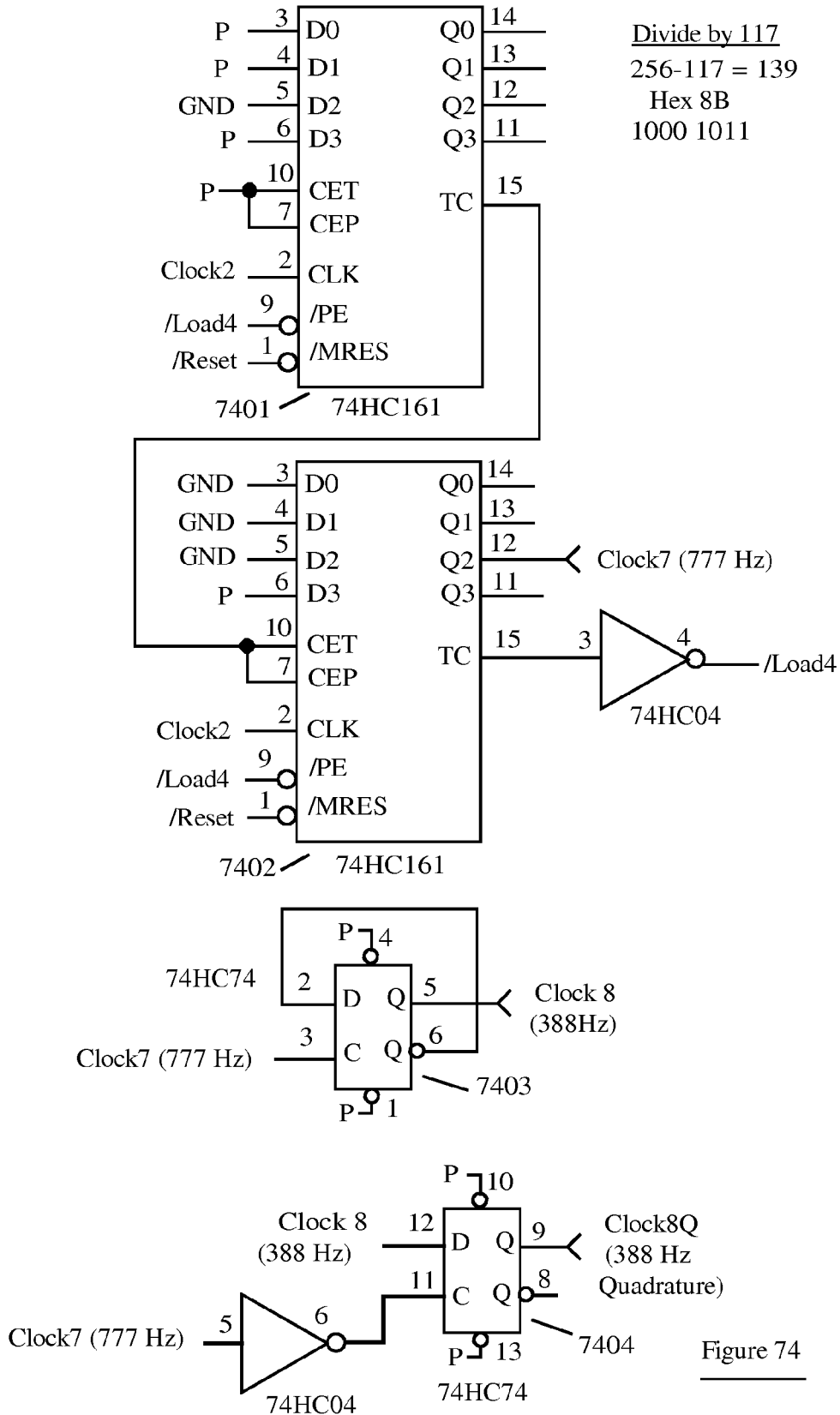


Figure 74

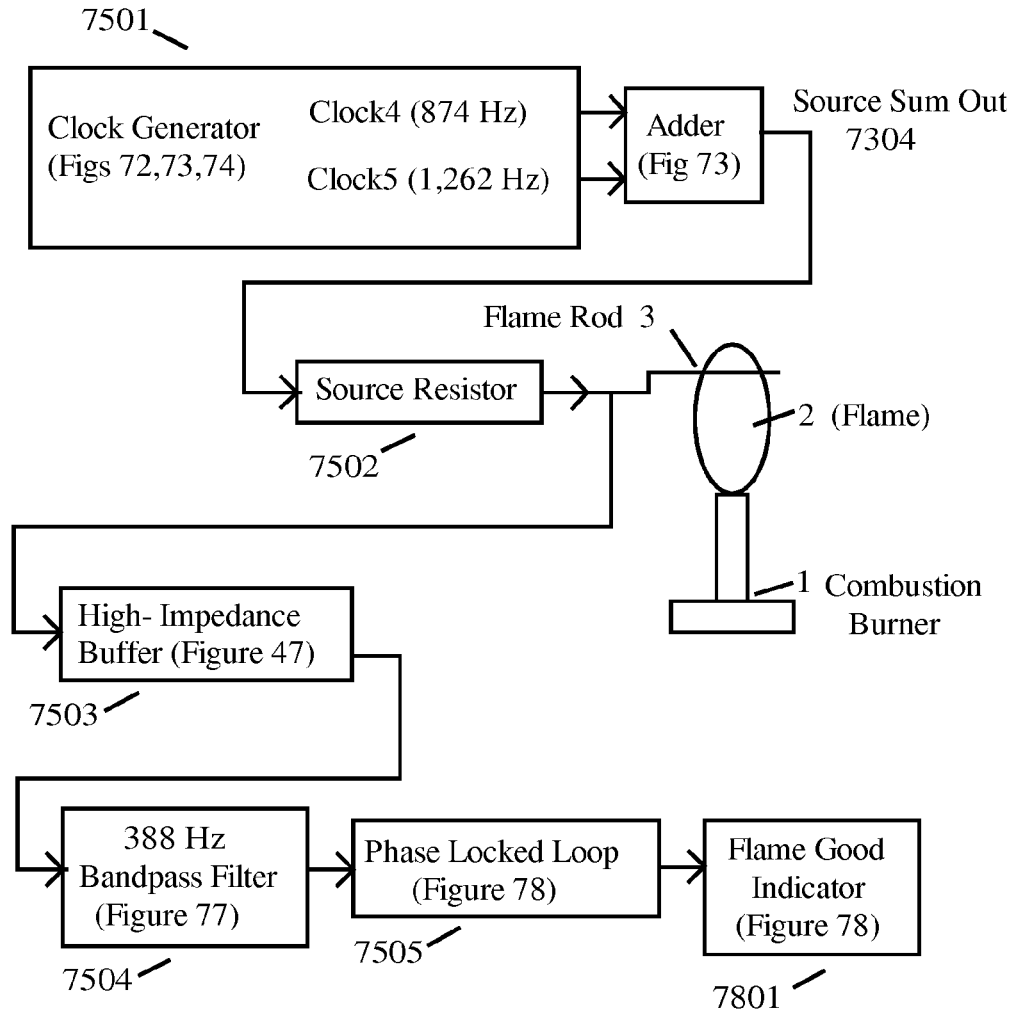


Figure 75

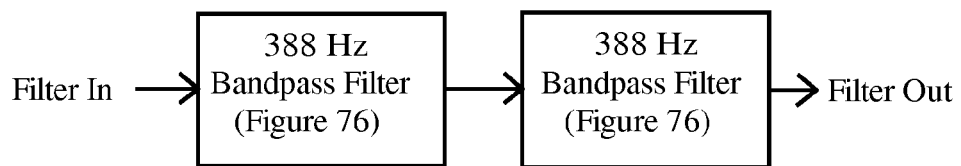
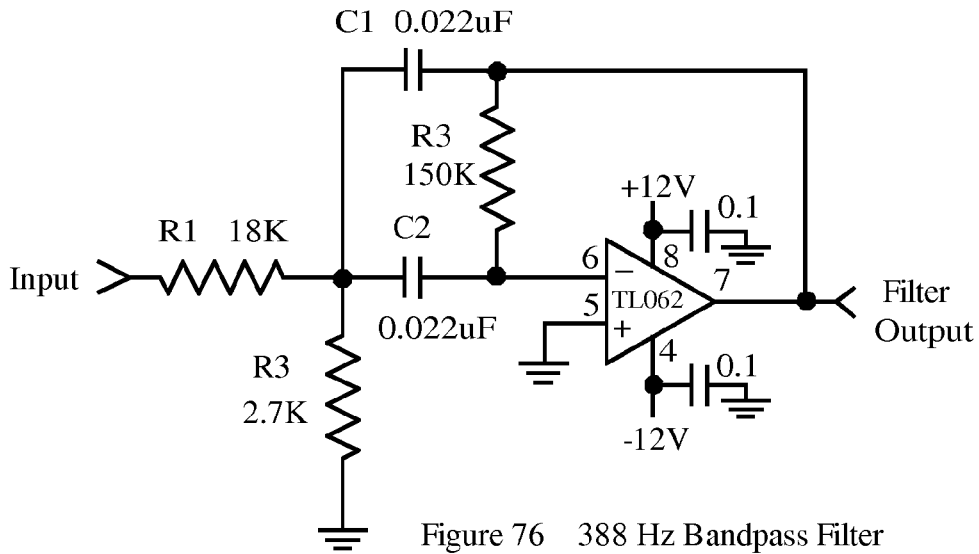


Figure 77 Two Cascaded Bandpass Filters

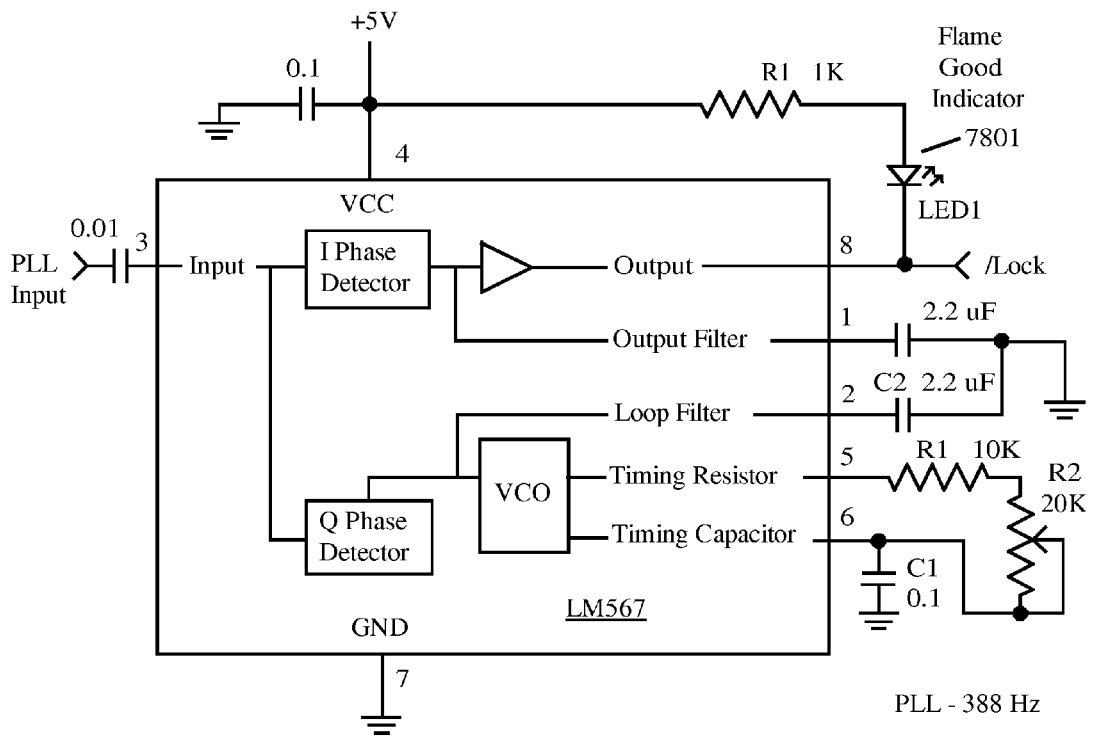


Figure 78

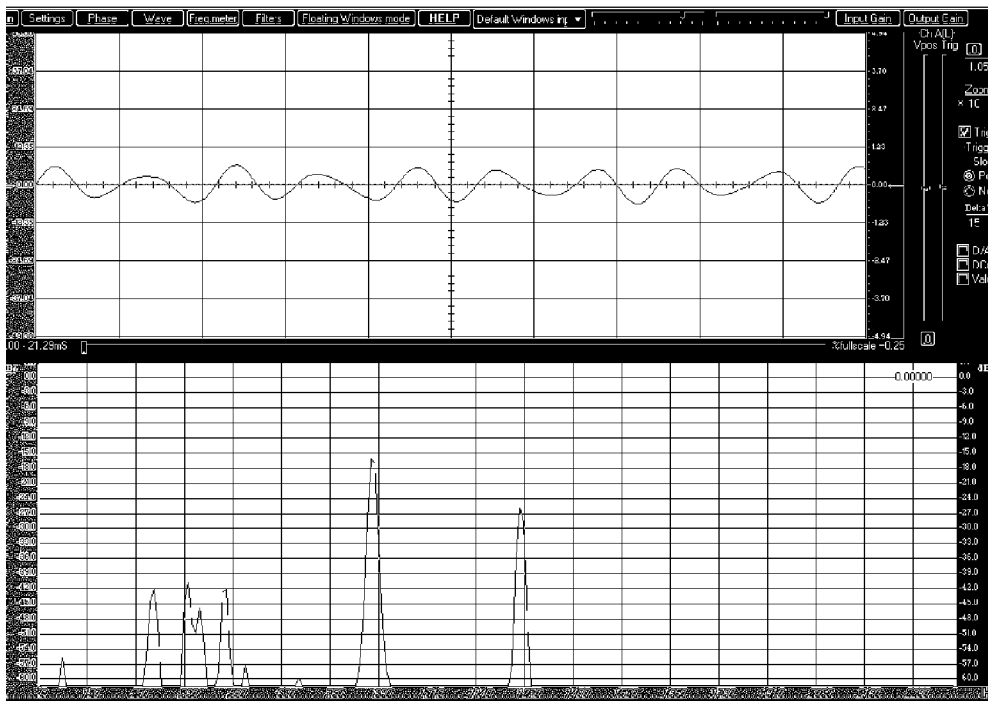


Figure 79a – Heterodyne Test – PLL Detector – Flame Off

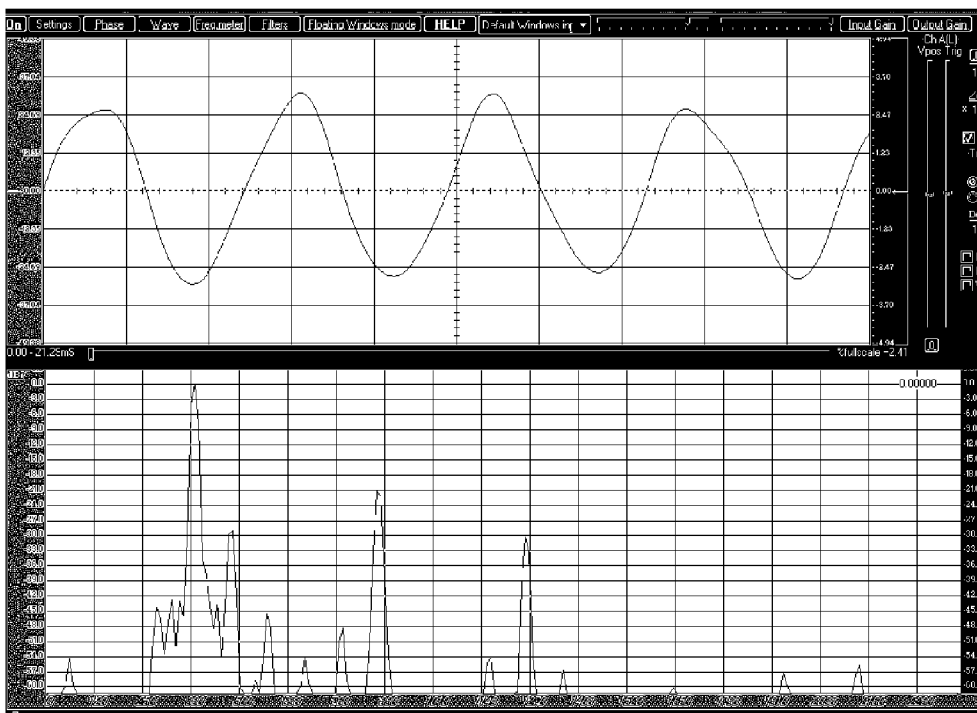


Figure 79b – Heterodyne Test – PLL Detector – Flame On

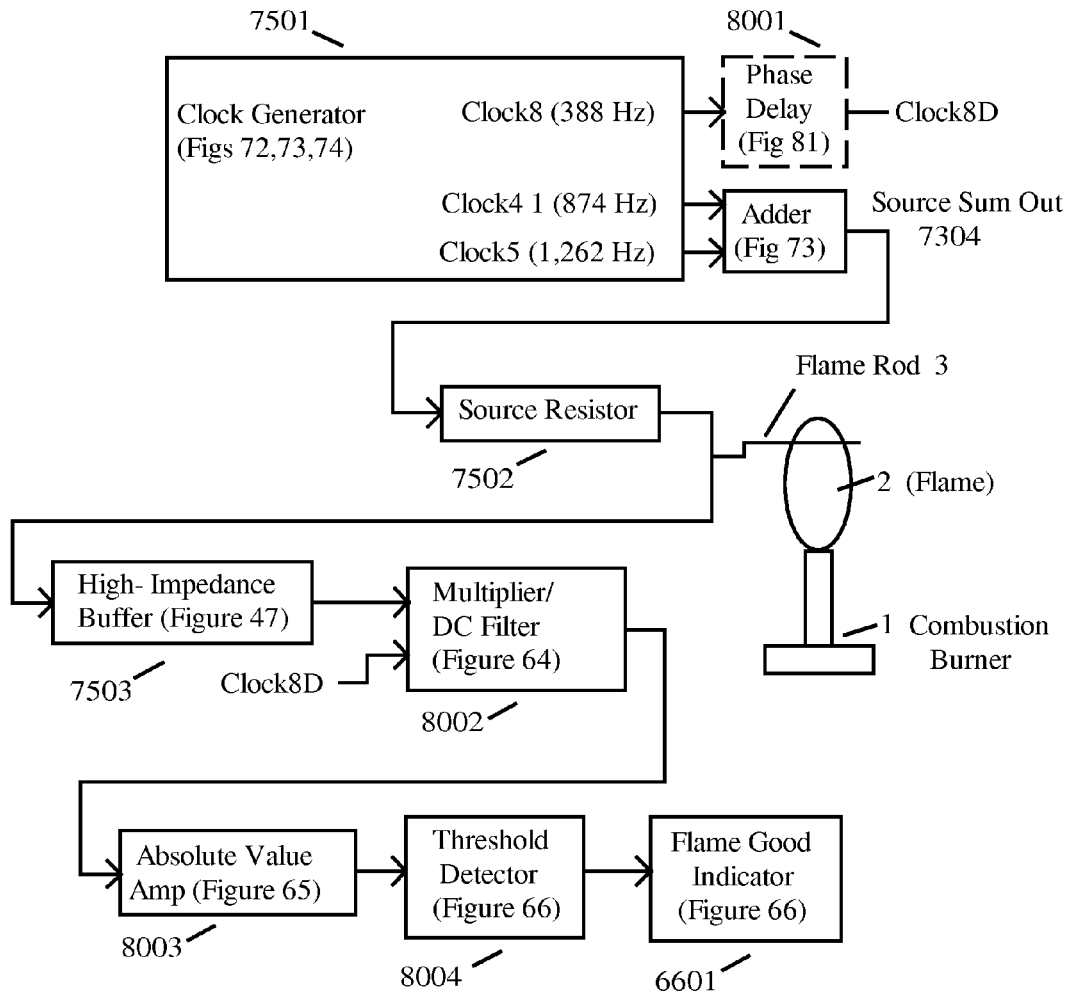


Figure 80

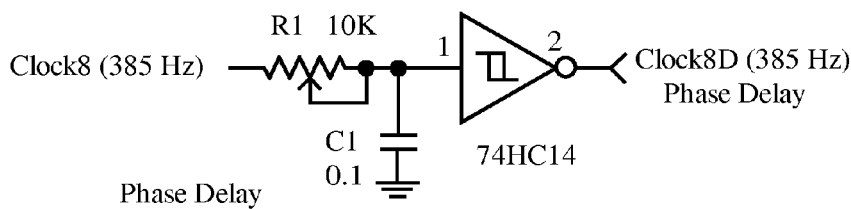


Figure 81

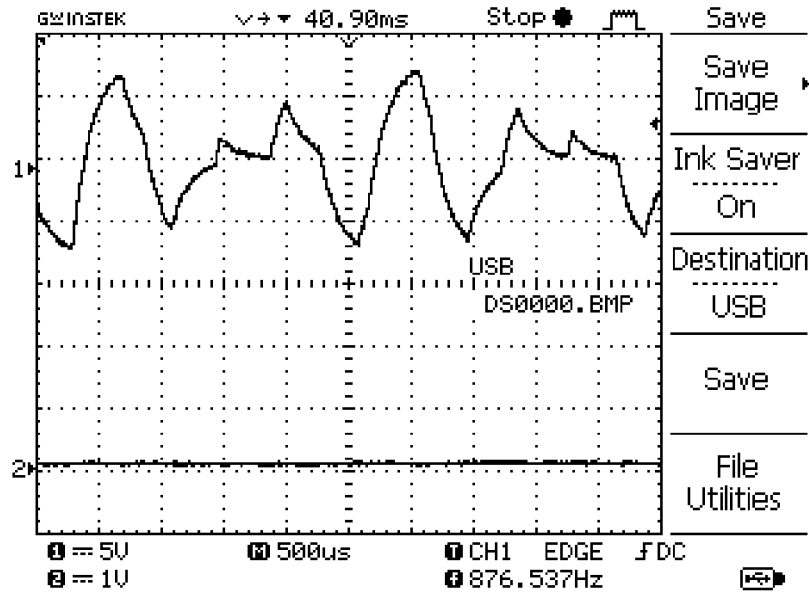


Figure 82a – Heterodyne Test – Simple Synchronous Detector – Flame Off

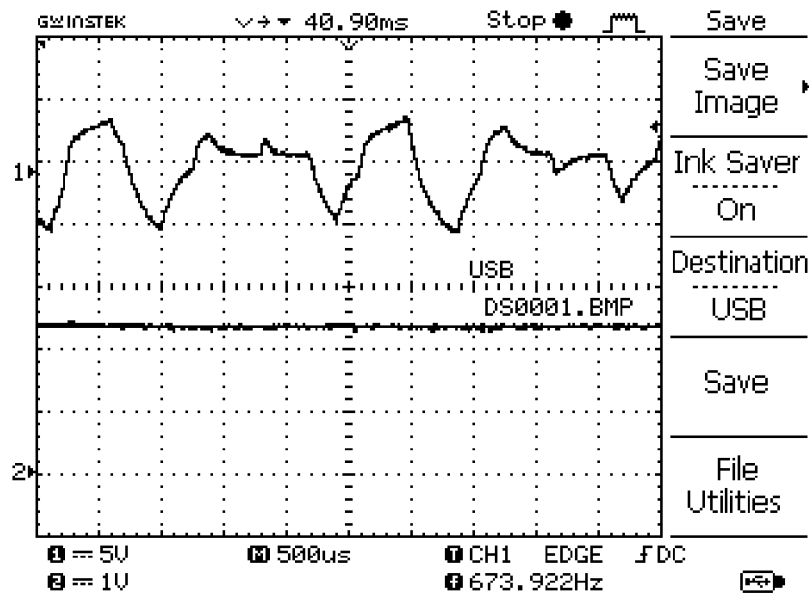


Figure 82b – Heterodyne Test – Simple Synchronous Detector – Flame On

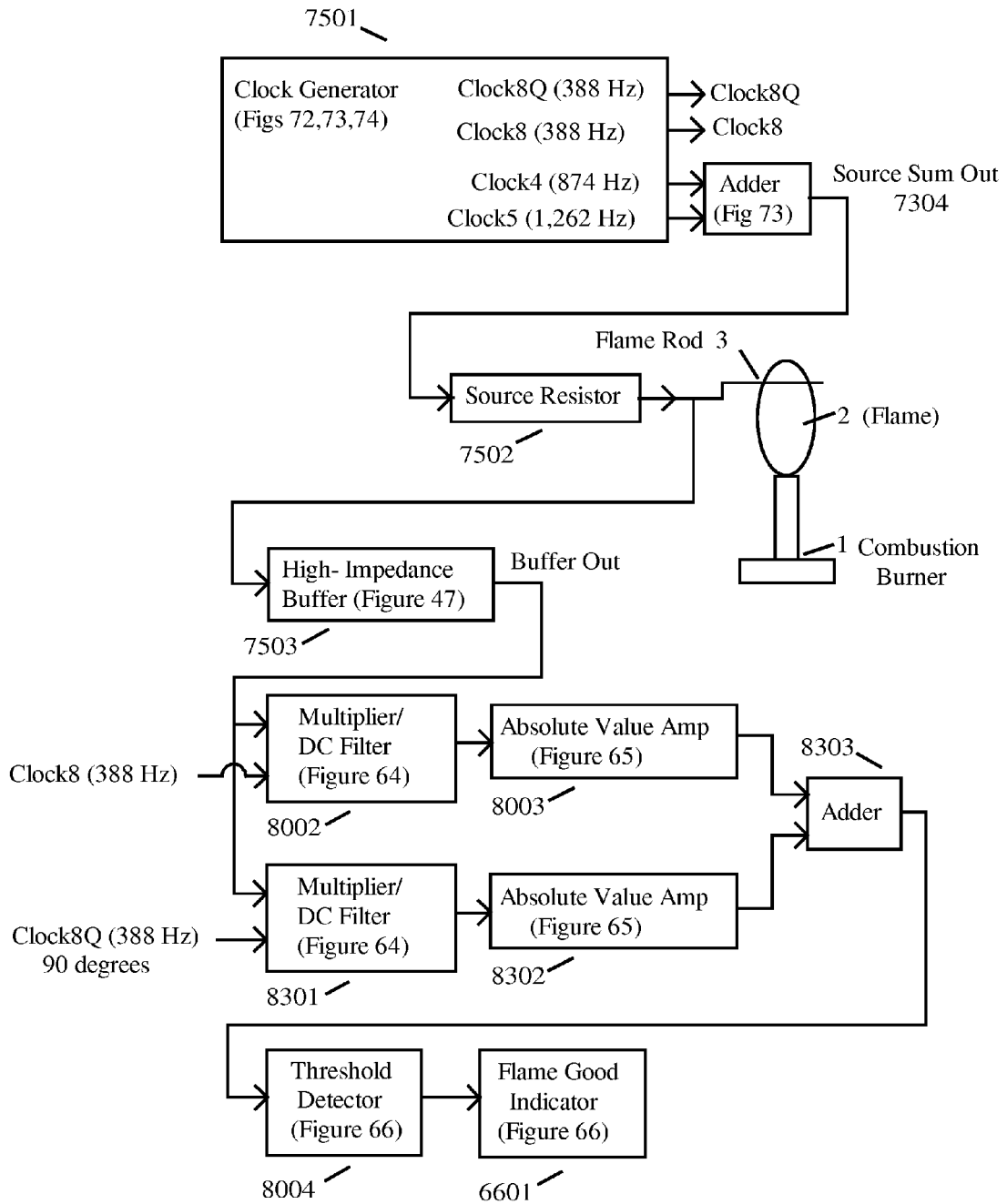


Figure 83

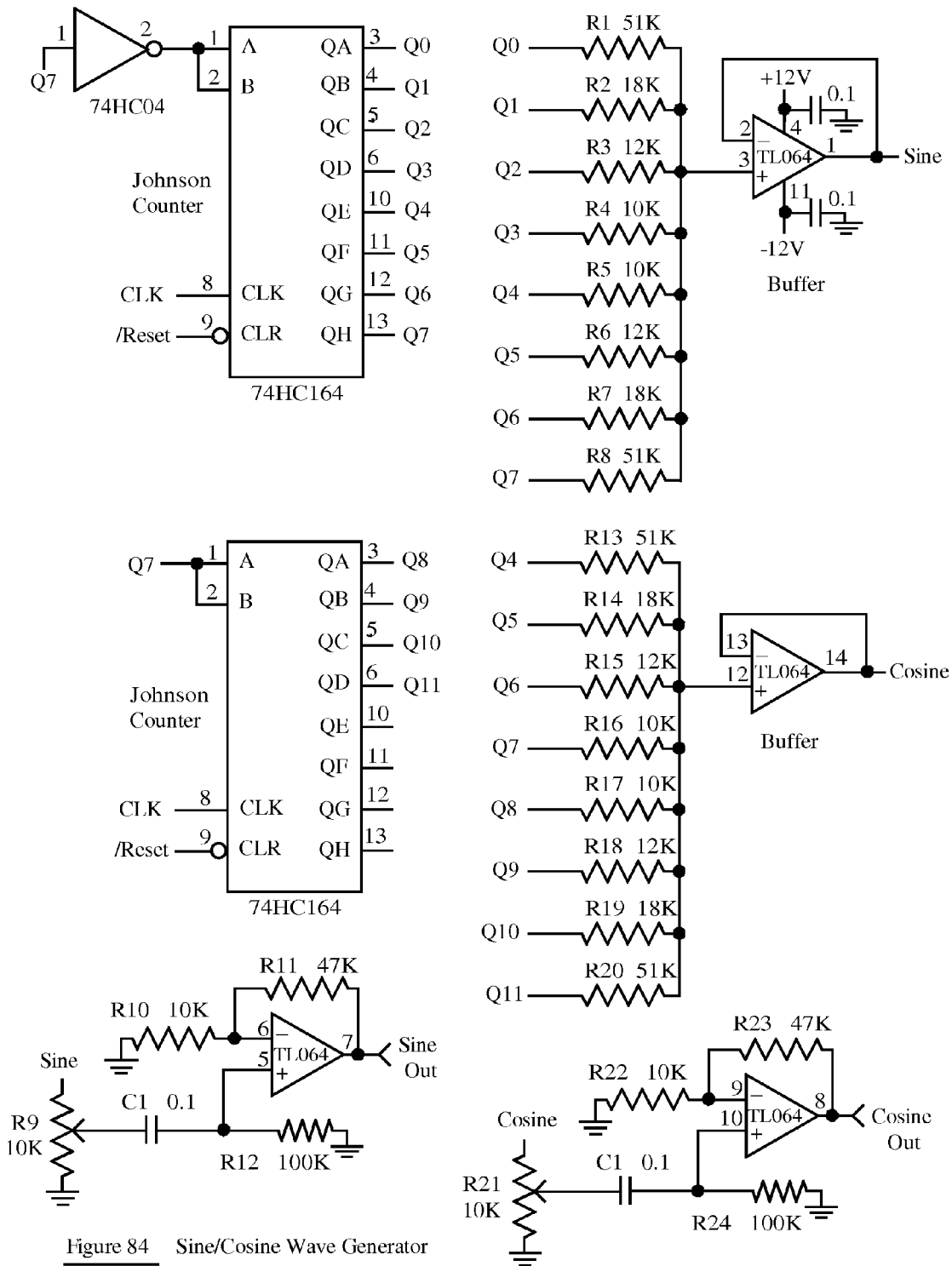


Figure 84 Sine/Cosine Wave Generator

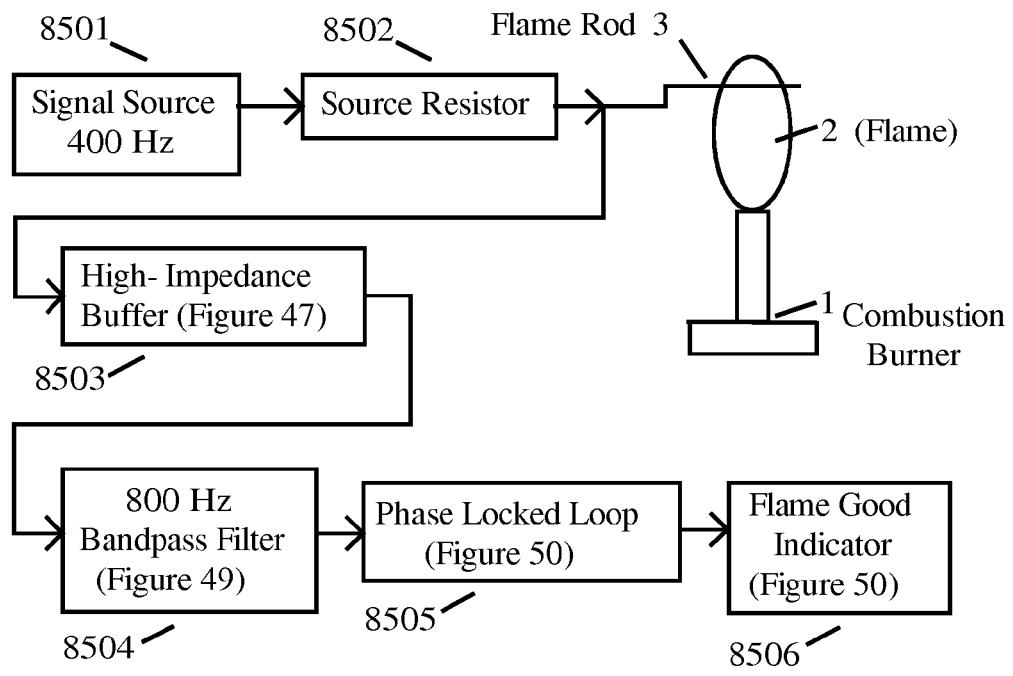


Figure 85

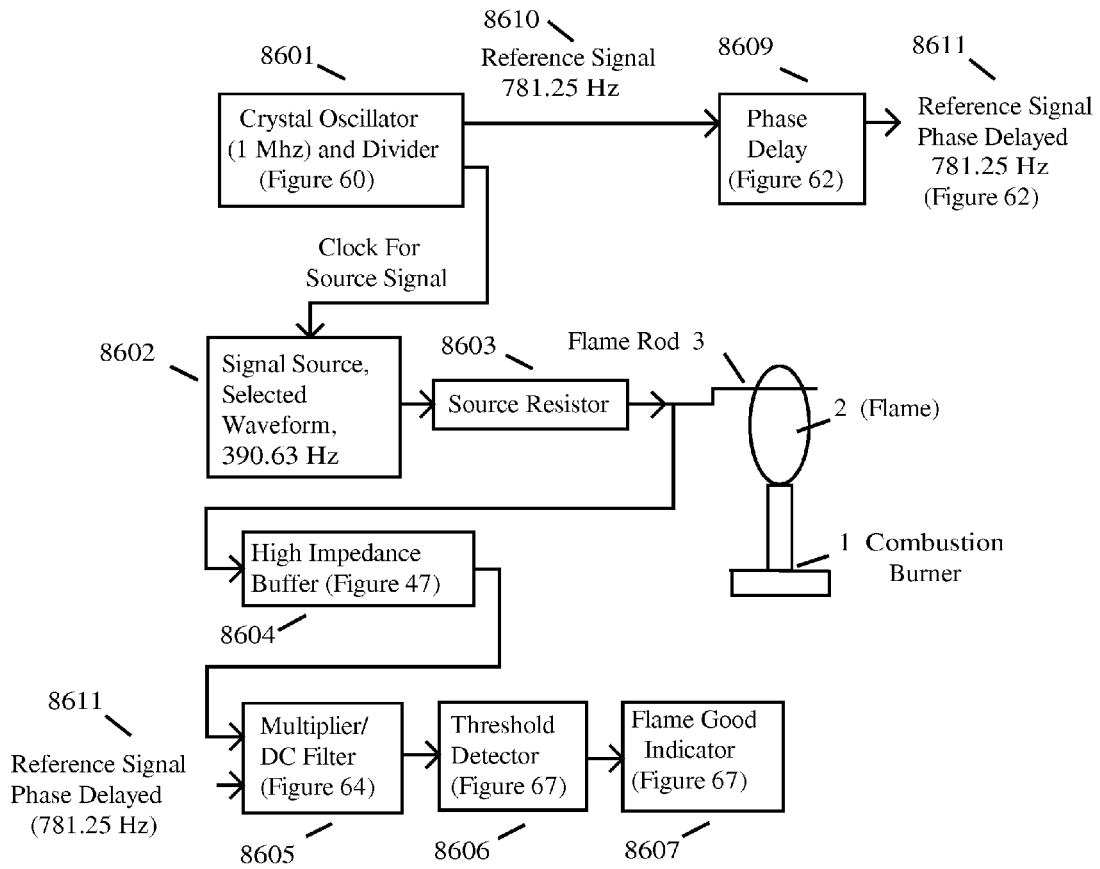


Figure 86

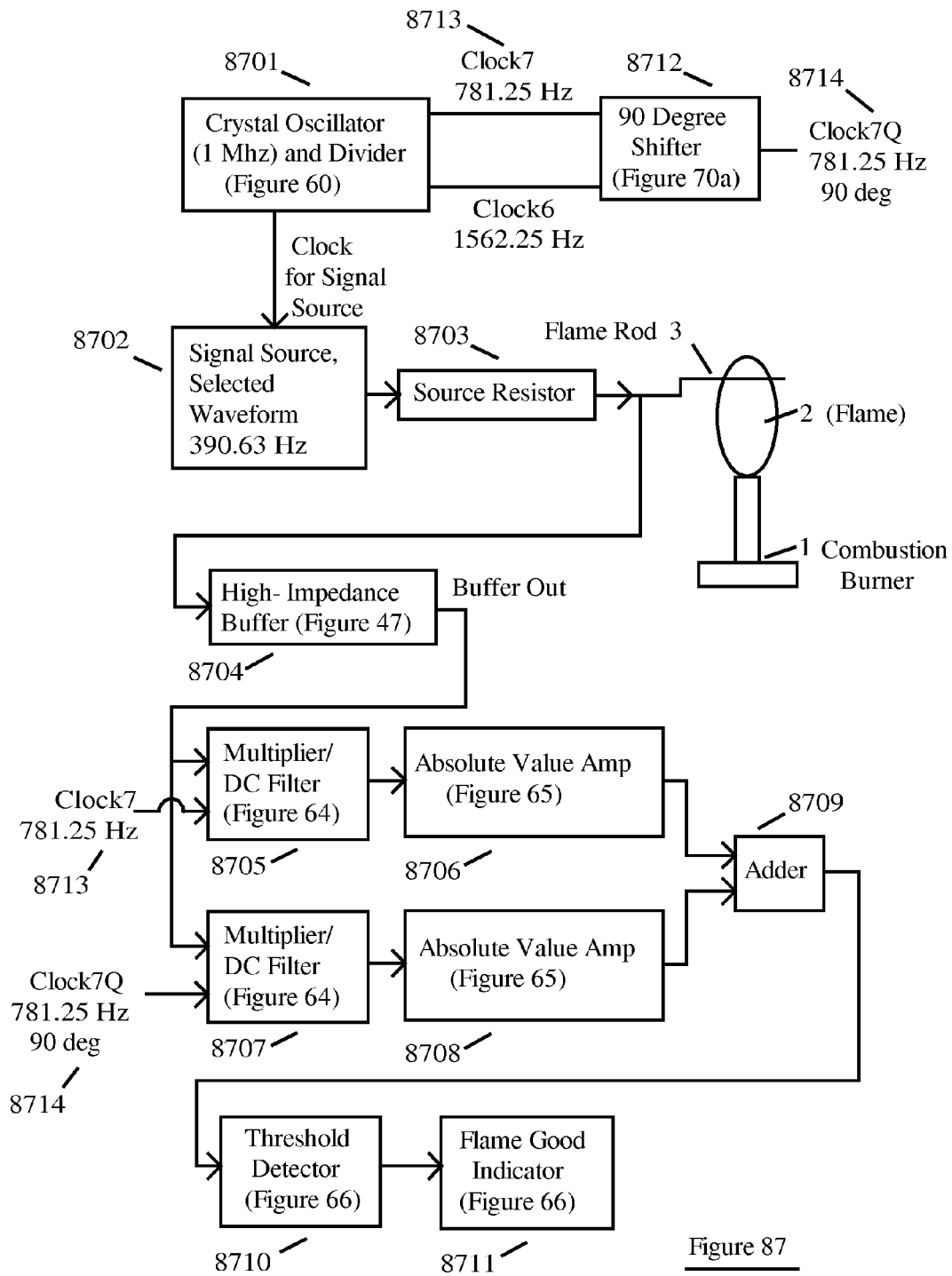


Figure 87

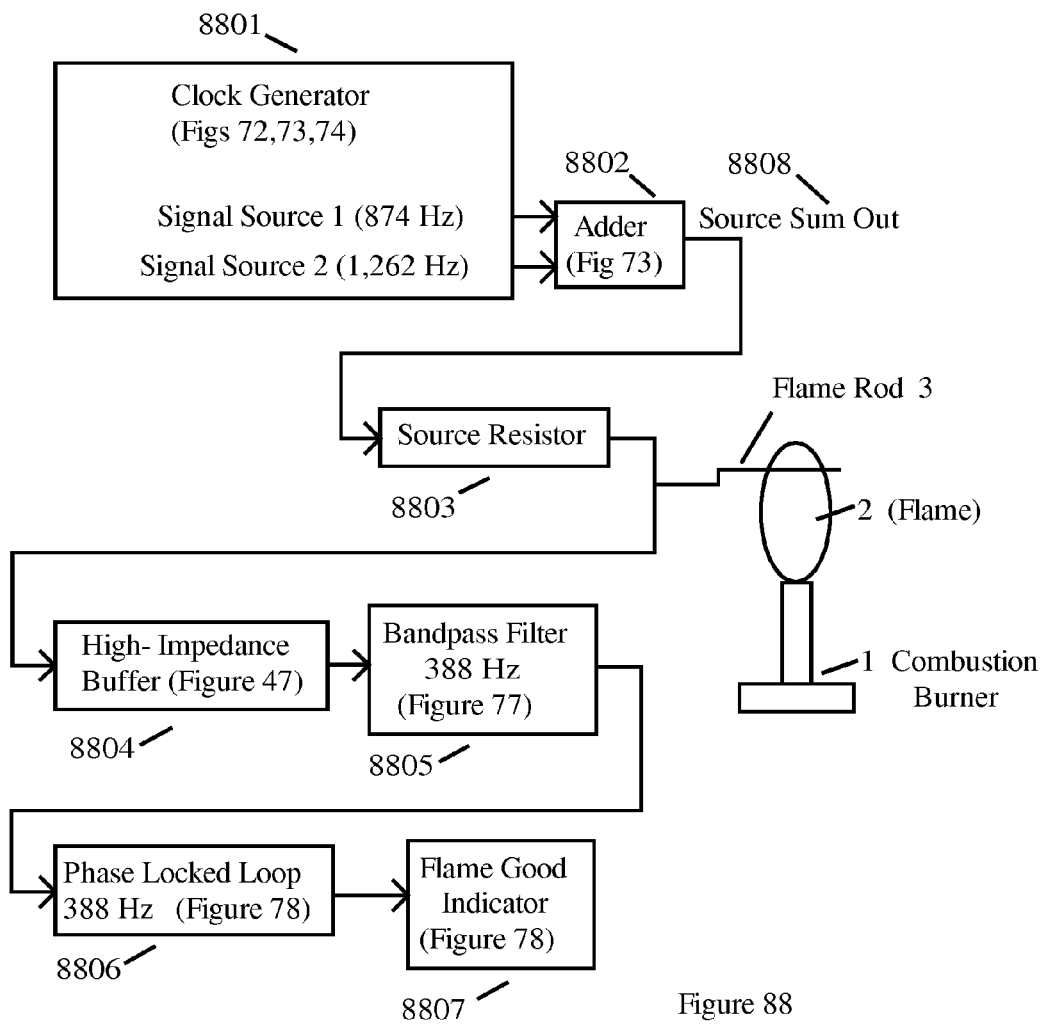


Figure 88

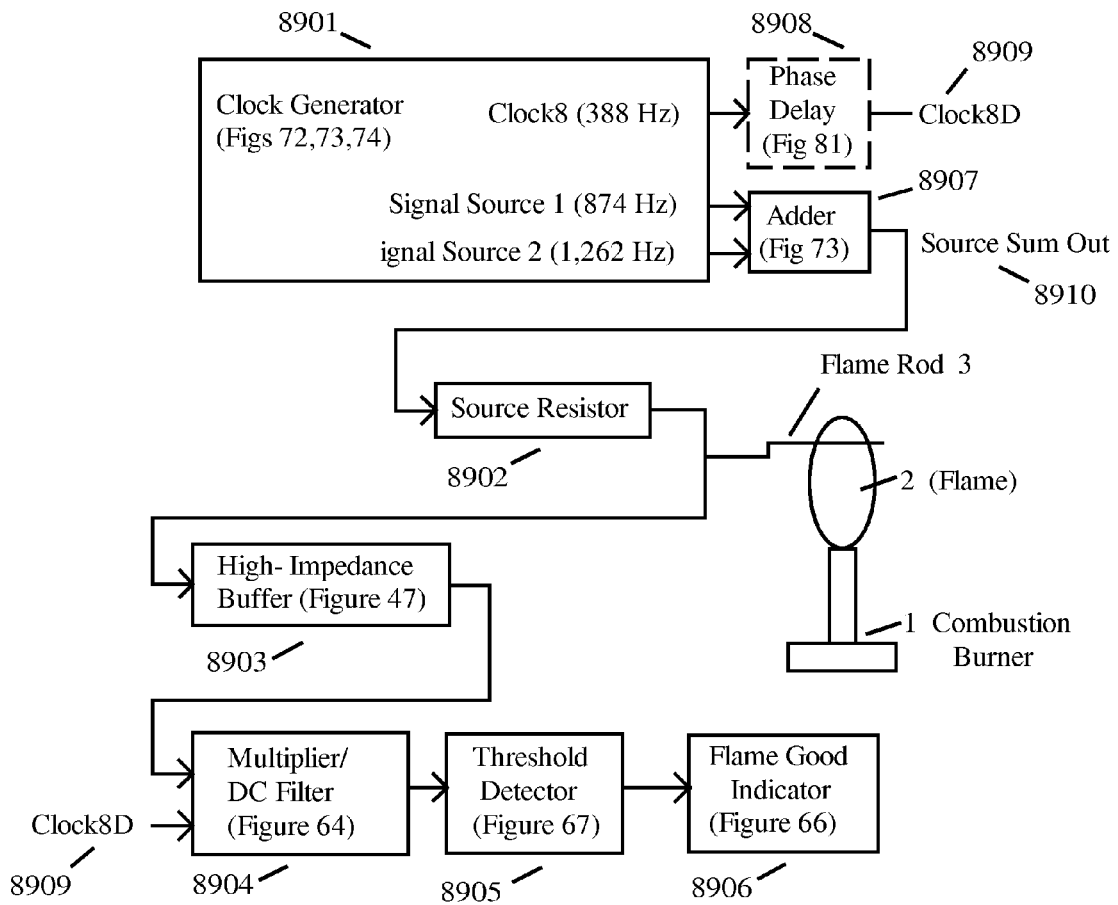


Figure 89

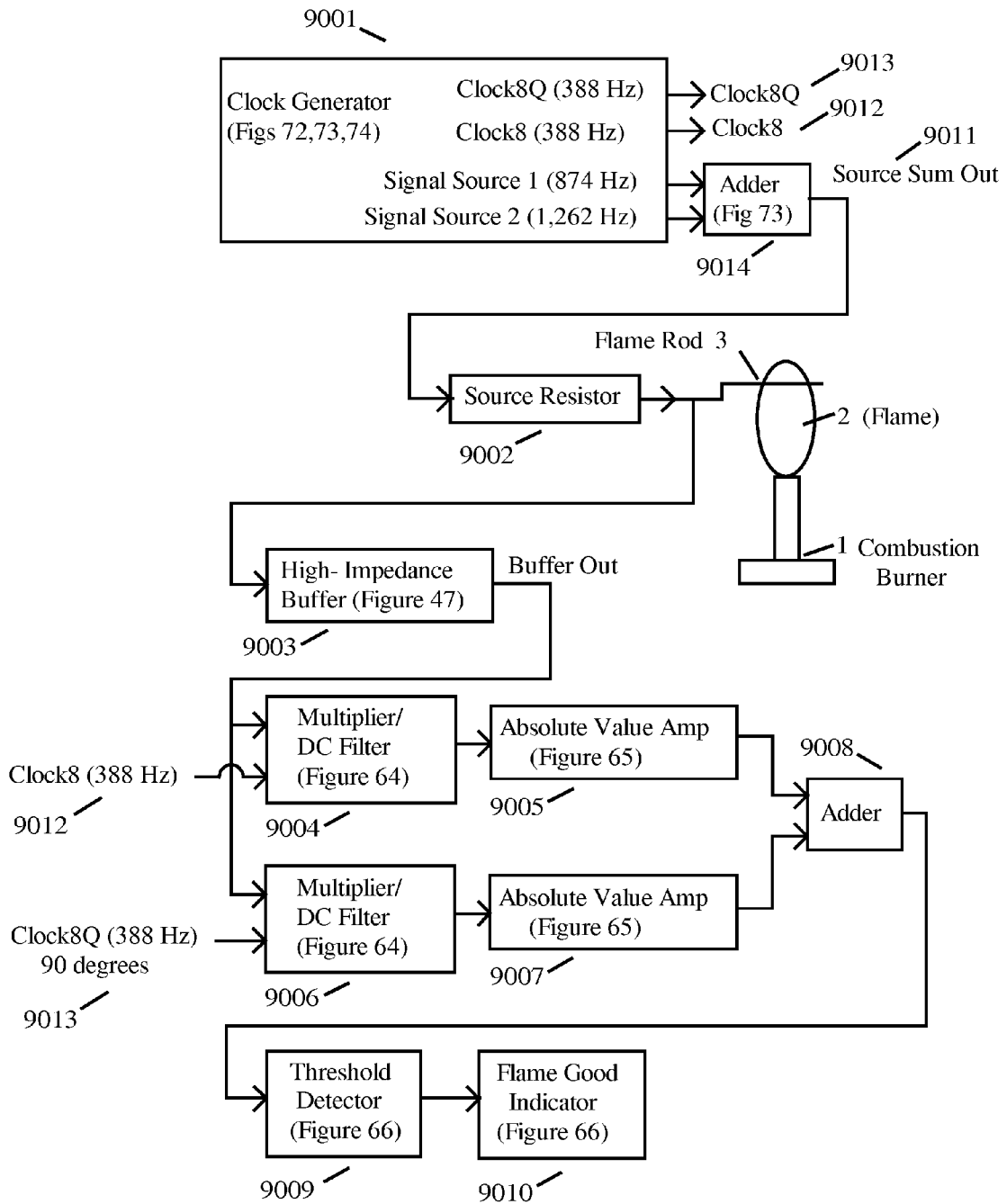


Figure 90