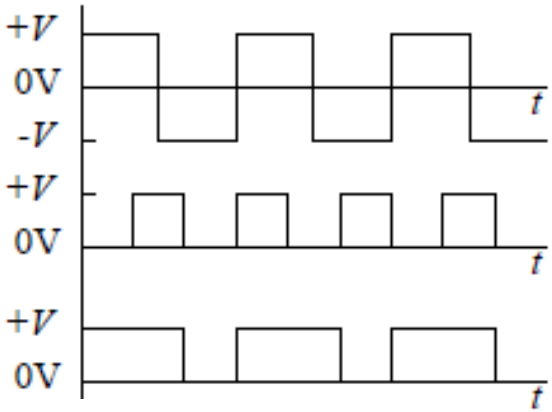
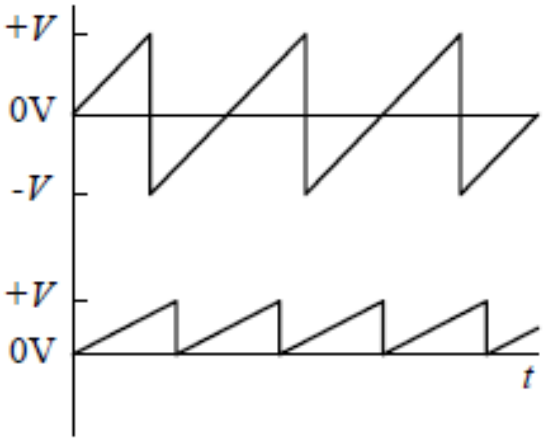
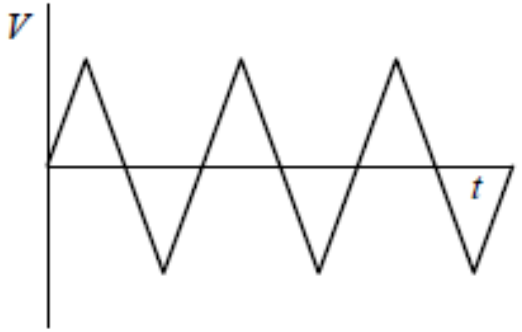
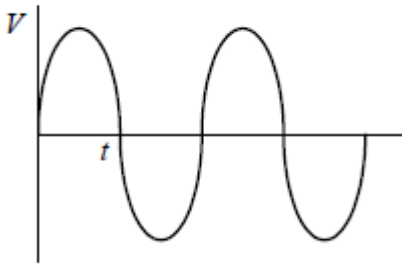
Oscillators and Timers

Different Types of Signals

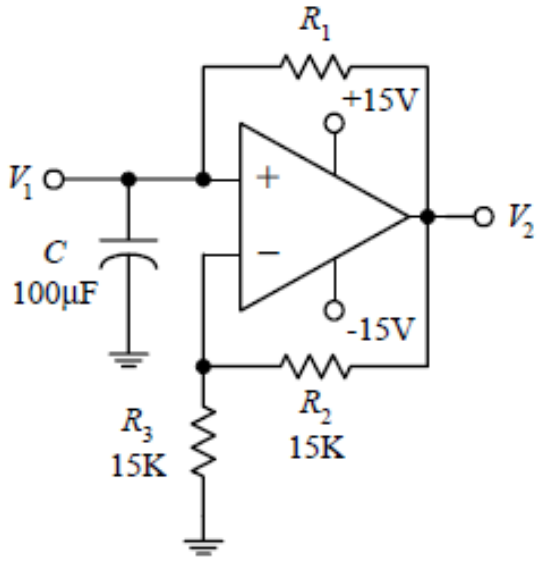


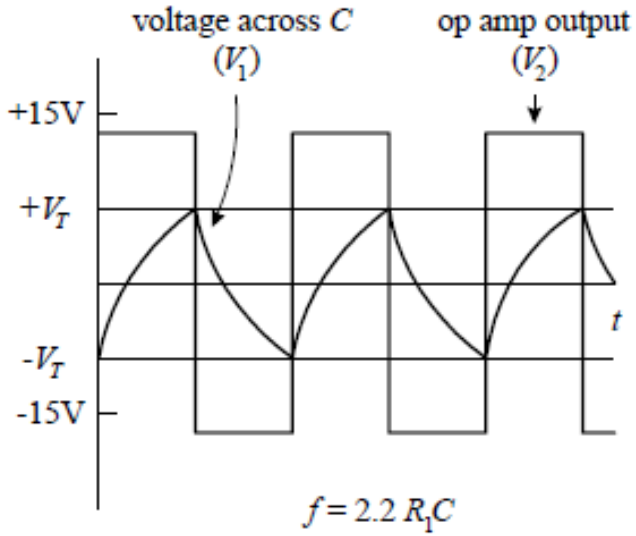






RC-Relaxation Oscillator





$$V_T = \frac{R_3}{R_3 + R_2} = \frac{15\ \text{k}\Omega}{15\ \text{k}\Omega + 15\ \text{k}\Omega}\,(+15\,\text{V}) = +7.5\,\text{V}$$

The 555 Timer IC

Huge applications:

- Digital clock waveform generator
- LED and Lamp flasher Circuits
- Tone generators
- One-shot timer circuits
- Bounce- free switches
- Triangular waveform generator
- Frequency Divider

How 555 Timer Works

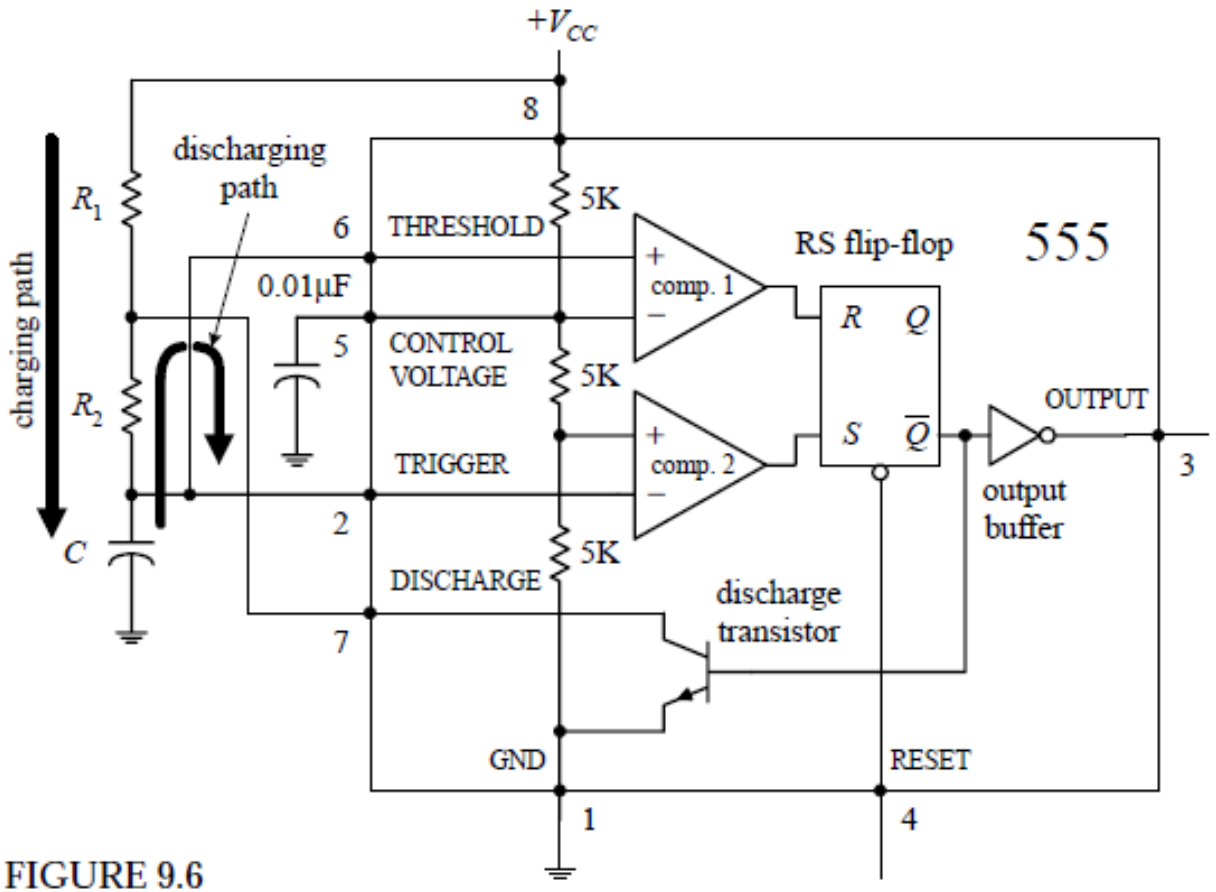
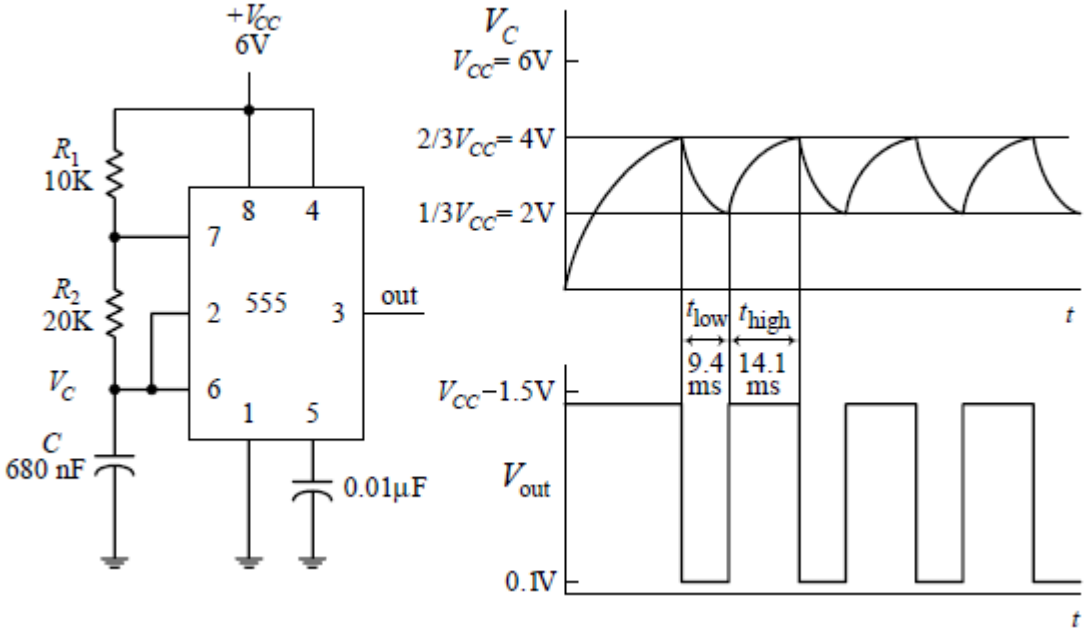


FIGURE 9.6

Basic Astable Operation



$$t_{low} = 0.693(20K)(680nF) = 9.6ms$$

$$t_{high} = 0.693(10K + 20K)(680nF) = 14.1ms$$

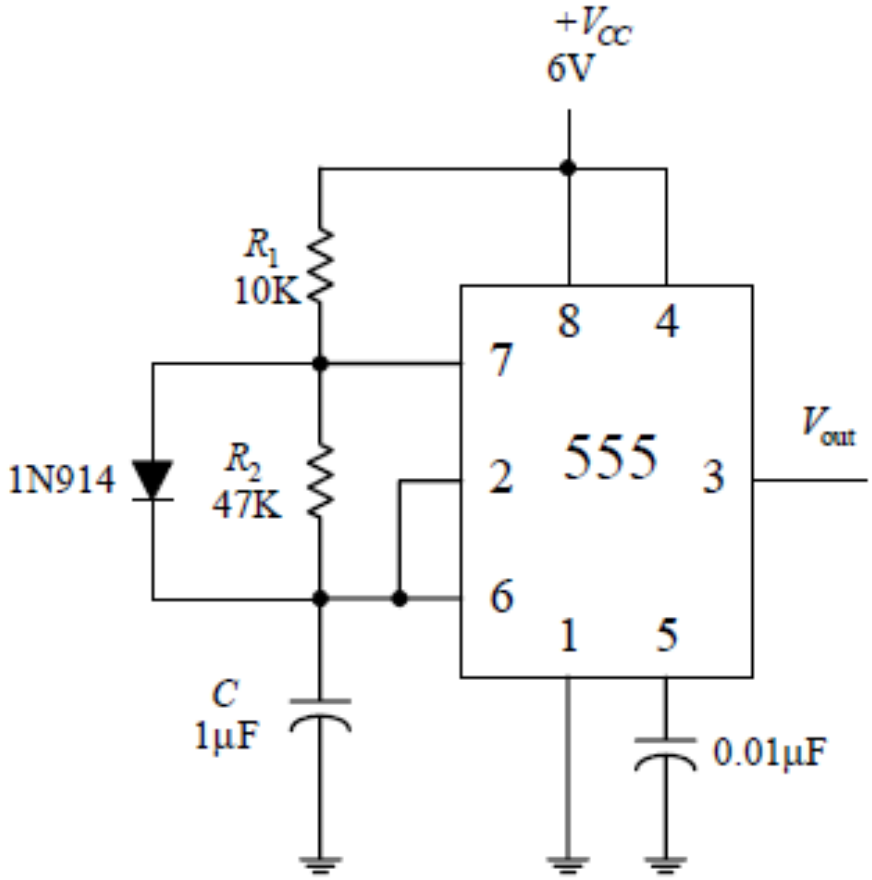
$$f = \frac{1}{9.6ms + 14.1ms} = 42Hz$$

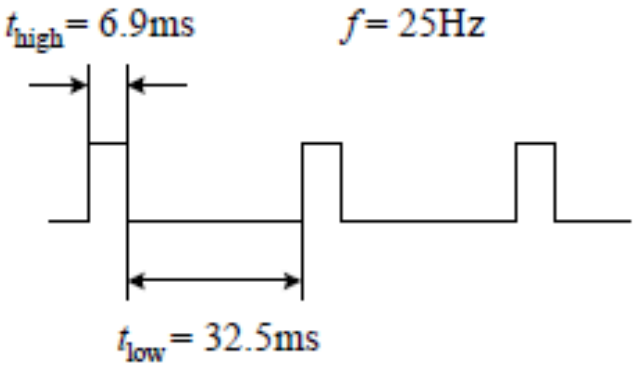
$$\text{duty cycle} = \frac{14.1ms}{14.1ms + 9.6ms} = 0.6$$

$$t_{low} = 0.693 R_2 C$$

$$t_{high} = 0.693(R_1 + R_2)C$$

Low-Duty-Cycle Operation (Astable Mode)





$$t_{high} = 0.693(10K)(1\mu F) = 6.9ms$$

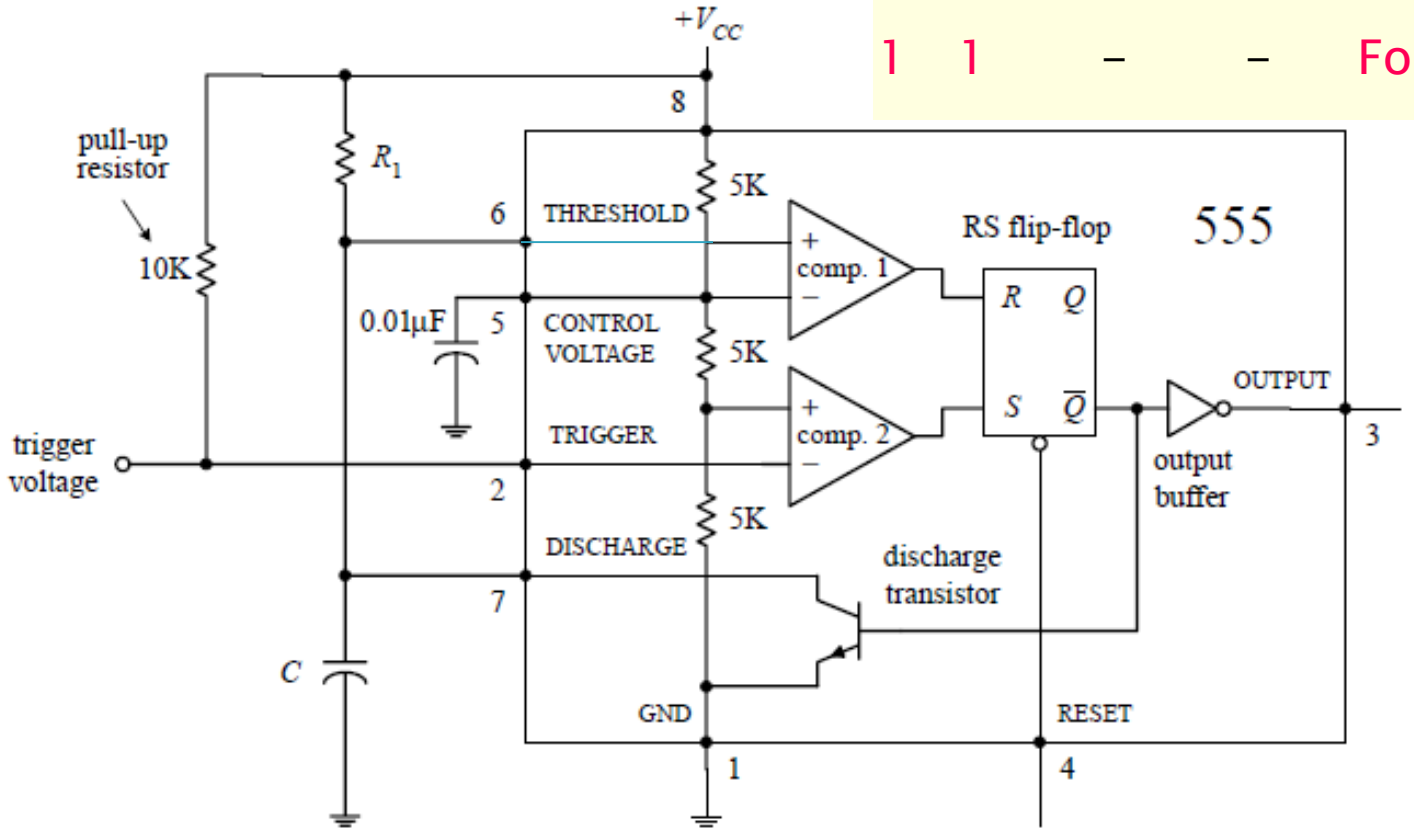
$$t_{low} = 0.693(47K)(1\mu F) = 32.5ms$$

$$f = \frac{1}{6.9ms + 32.5ms} = 25Hz$$

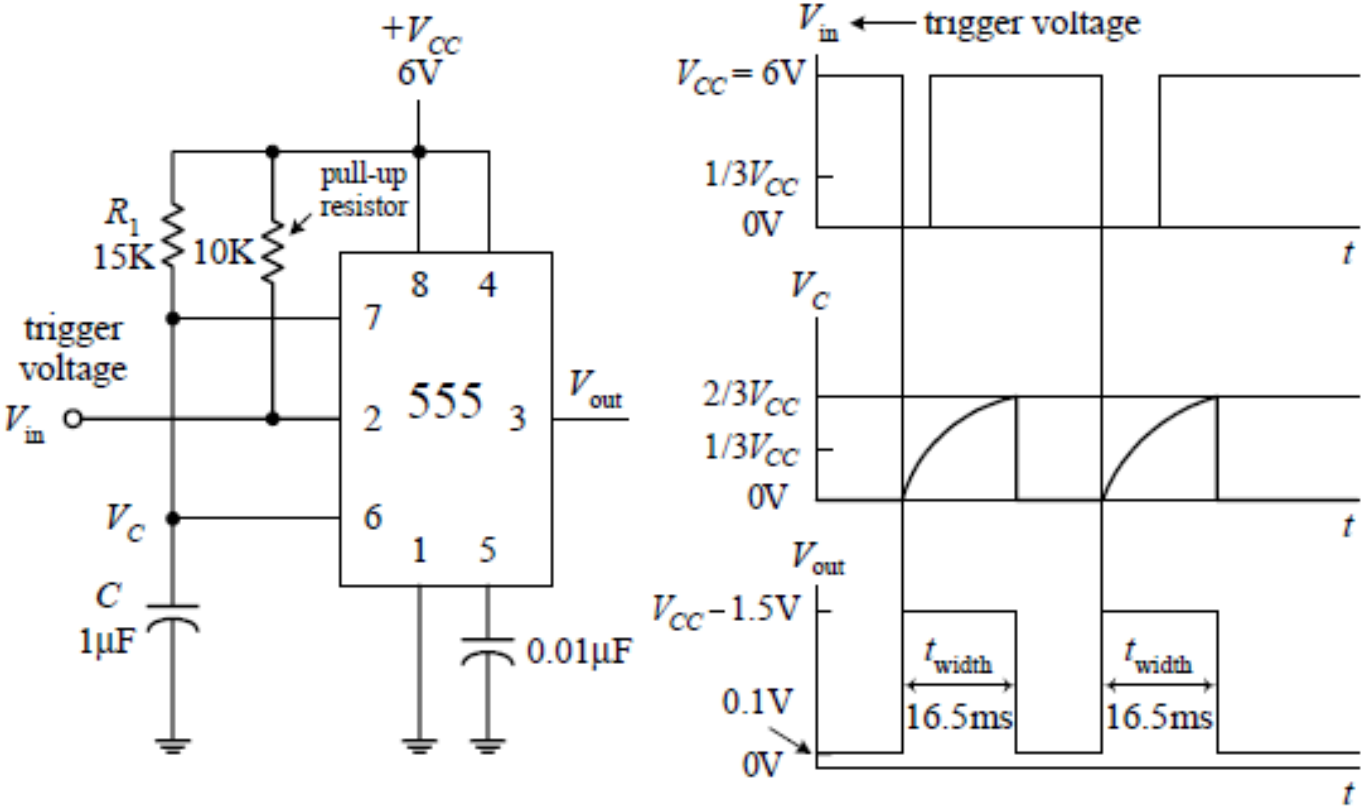
$$\text{duty cycle} = \frac{6.9ms}{6.9ms + 32.5ms} = 0.18$$

Monostable

S	R	Q	/Q	Remark
0	0	Q_n	$/Q_n$	Save the state
1	0	1	0	Set
0	1	0	1	Reset
1	1	–	–	Forbidden



Monostable Mode

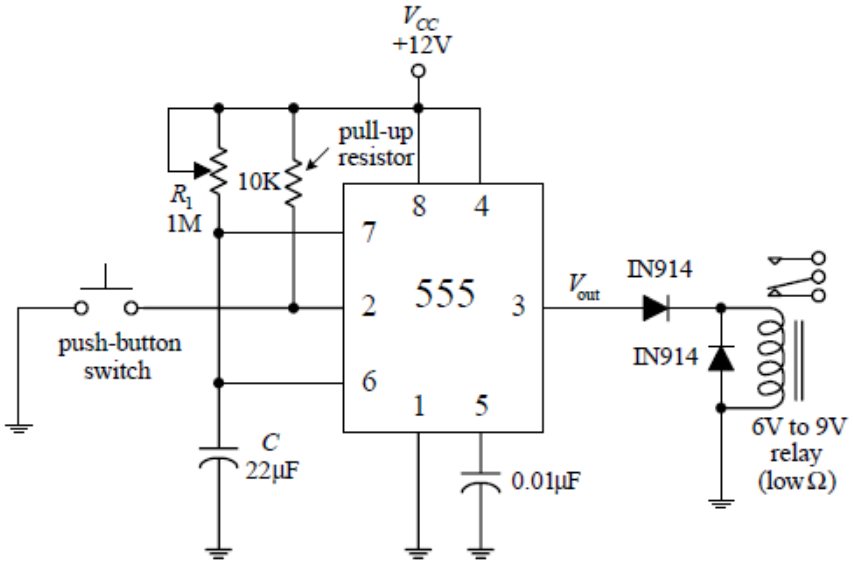


$t_{width} = 1.10\ R_1 C$

$t_{width} = 1.10\ (15\text{K})(1\mu\text{F}) = 16.5\text{ms}$

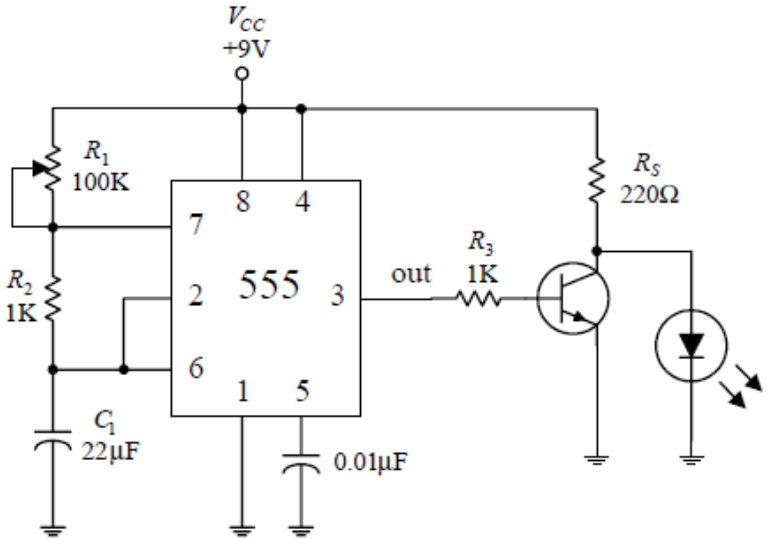
Applications

Relay Driver (Delay Timer)



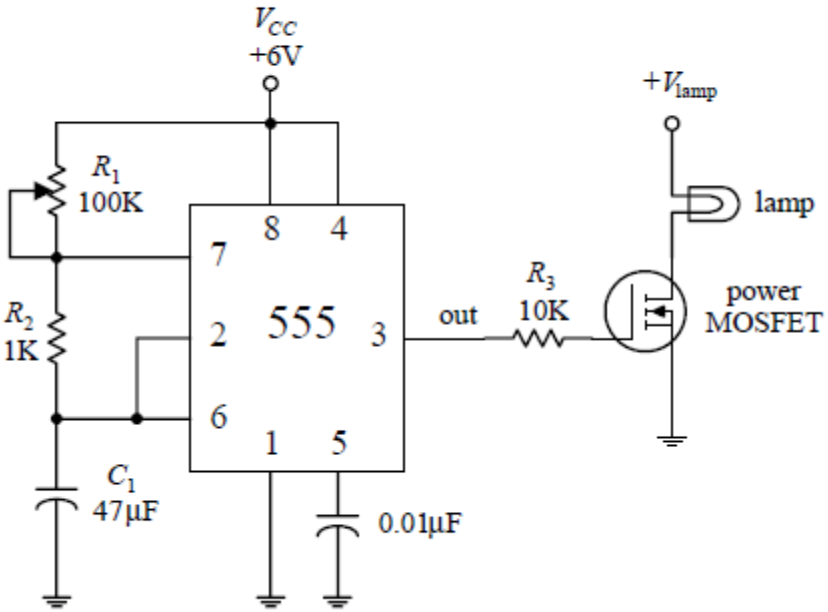
LED and Lamp Flasher and Metronome

LED Flasher

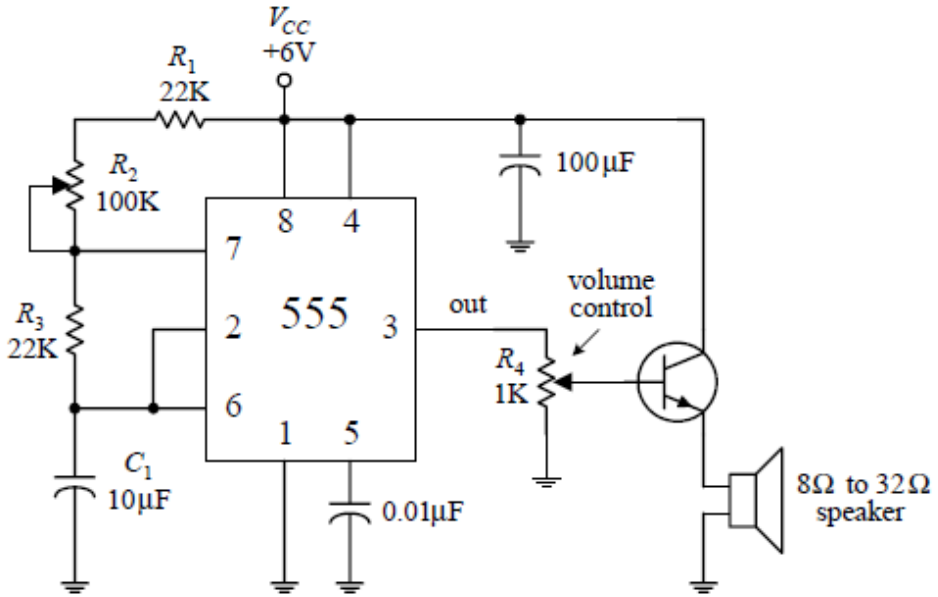


Applications

Lamp Flasher

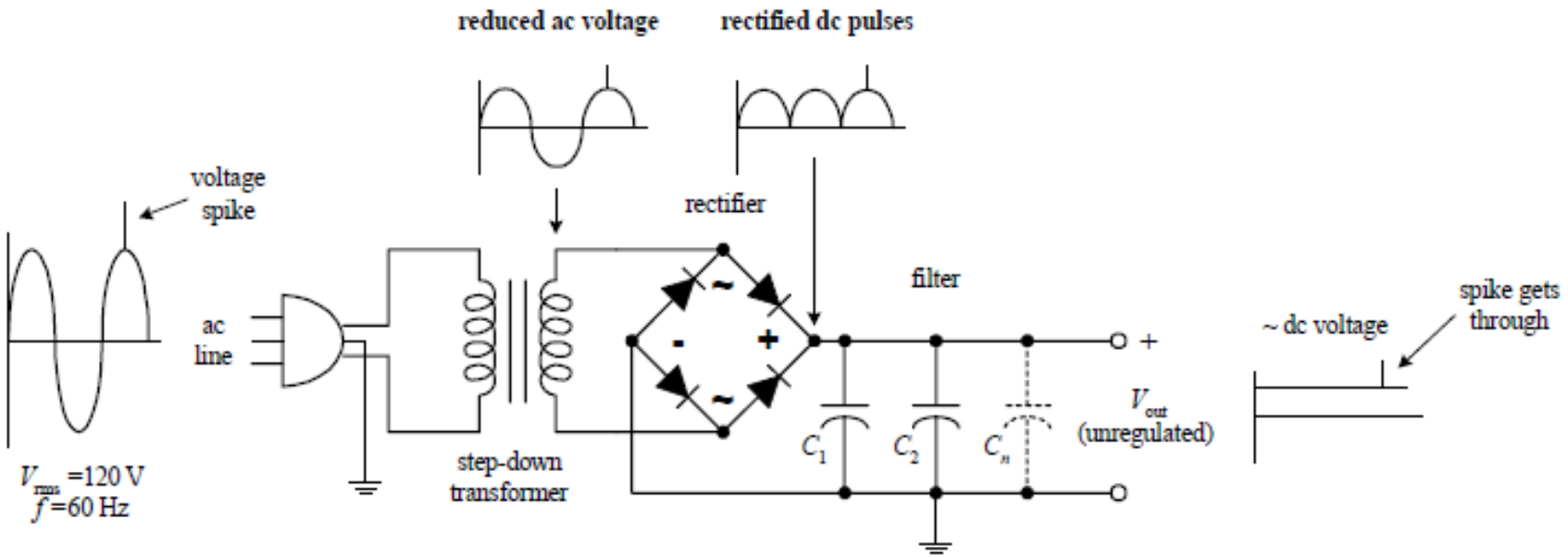


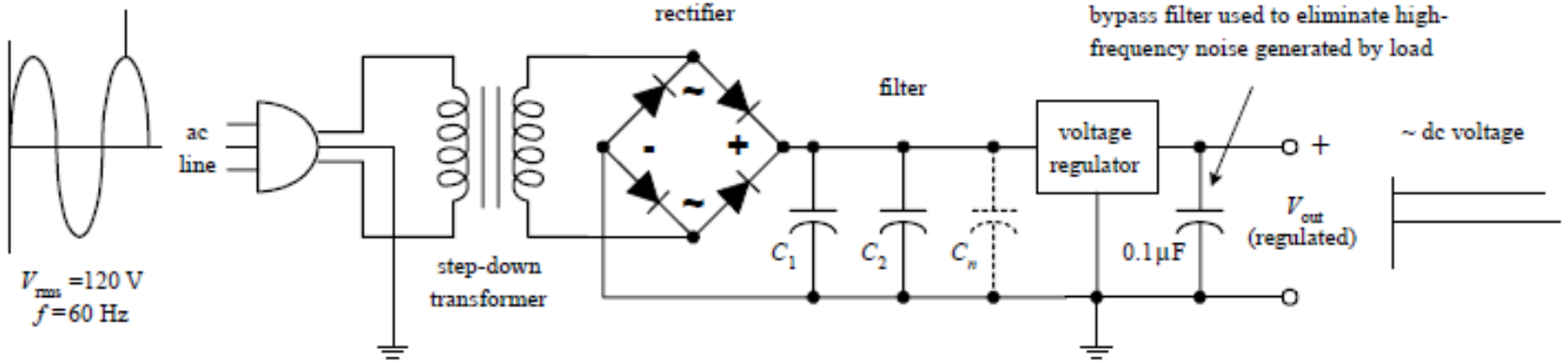
Metronome



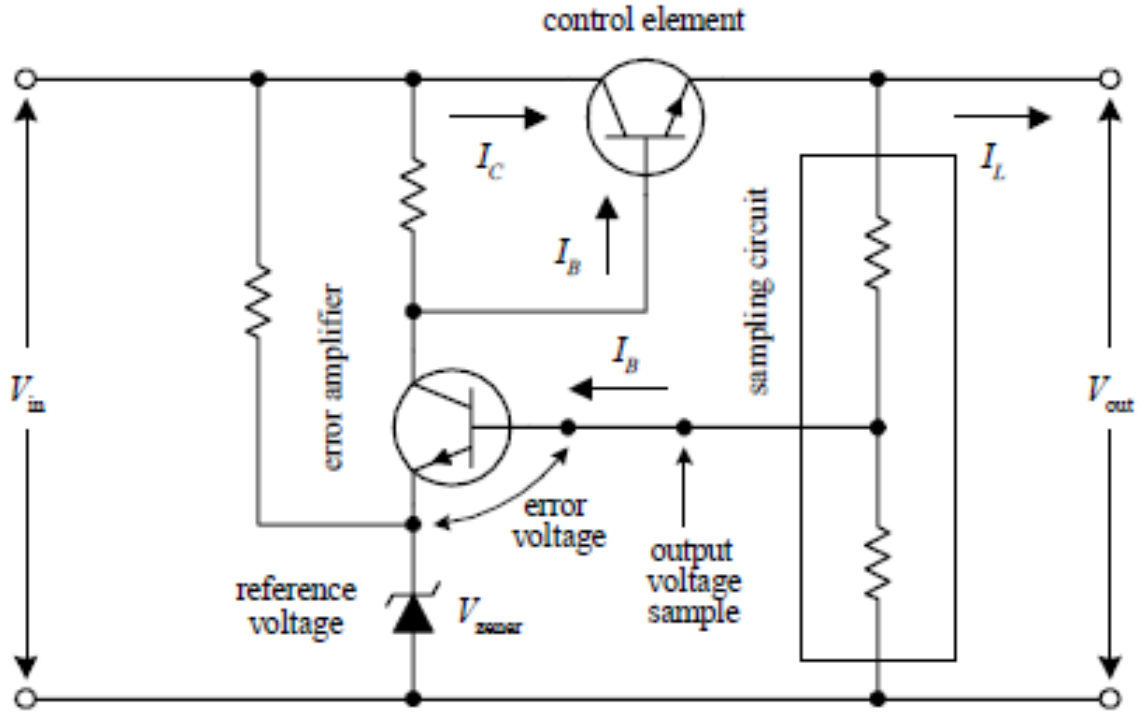
Voltage Regulators and Power Supplies

Power Supply



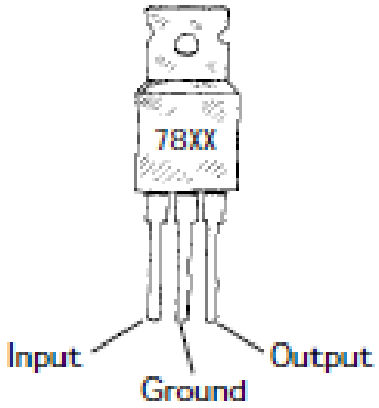


Voltage Regulator

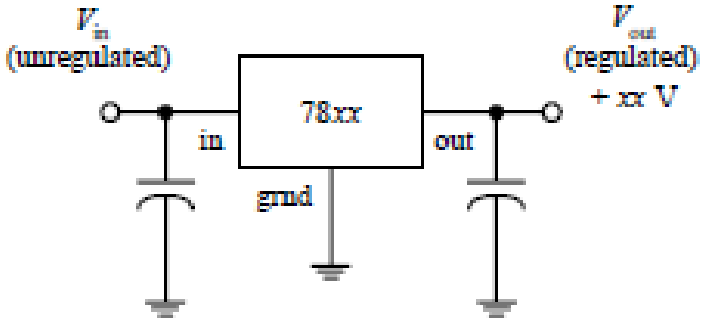


Fixed IC Regulator

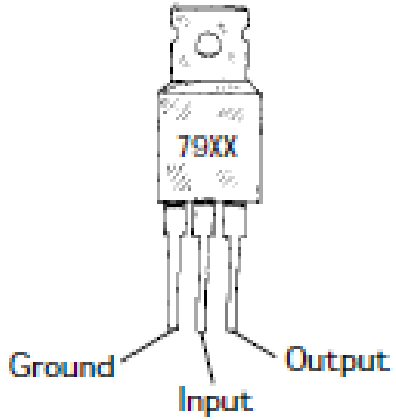
Positive voltage regulator



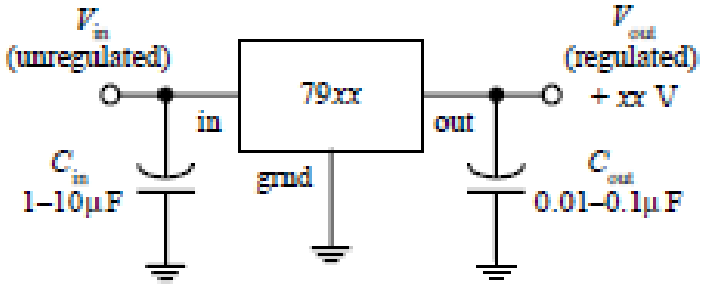
positive voltage regulator



Negative voltage regulator



negative voltage regulator



Adjustable IC Regulators

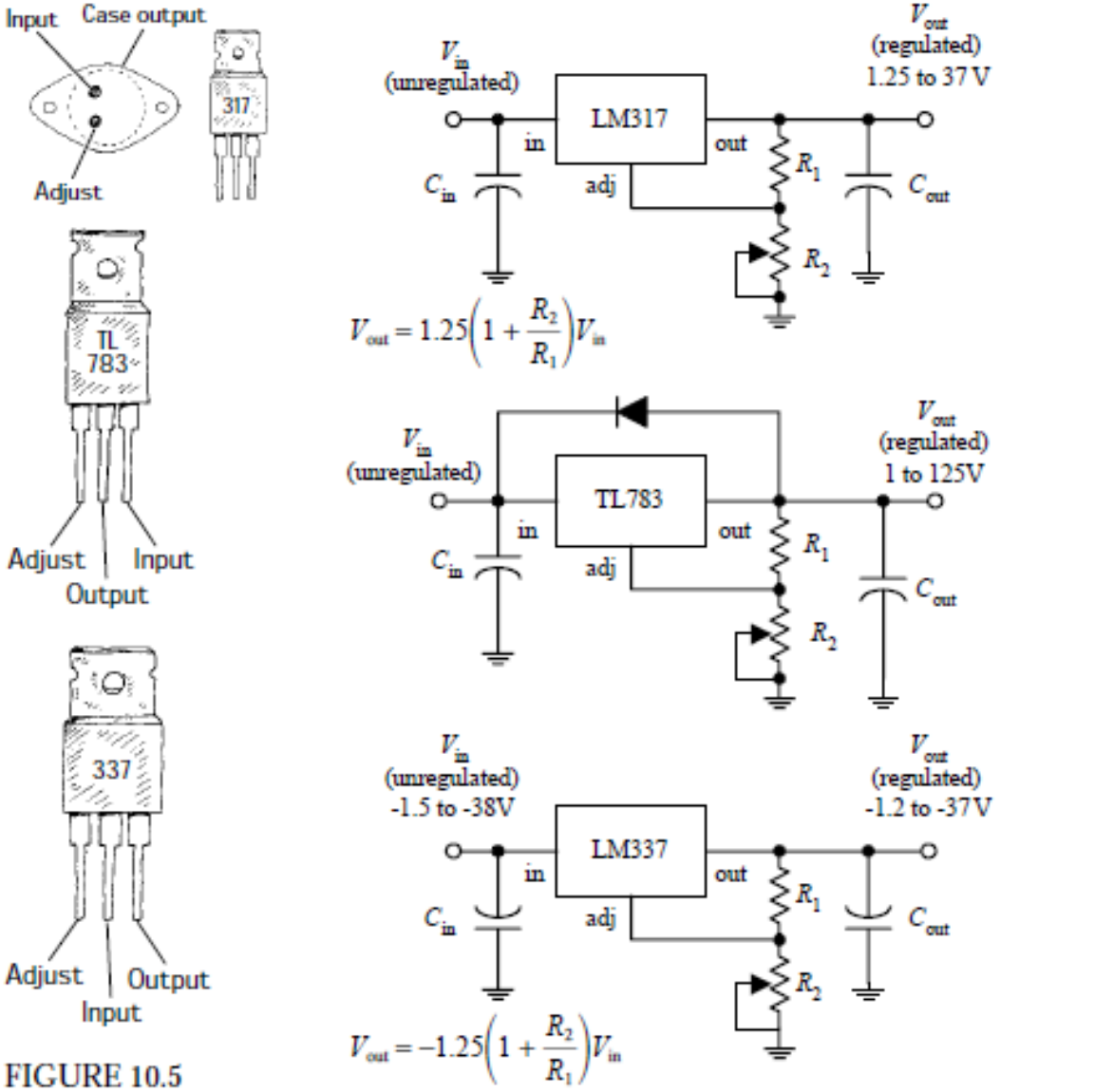
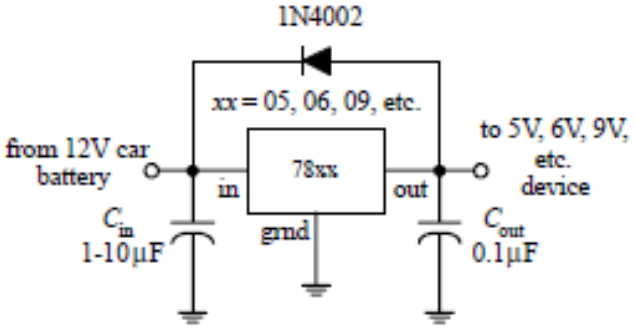


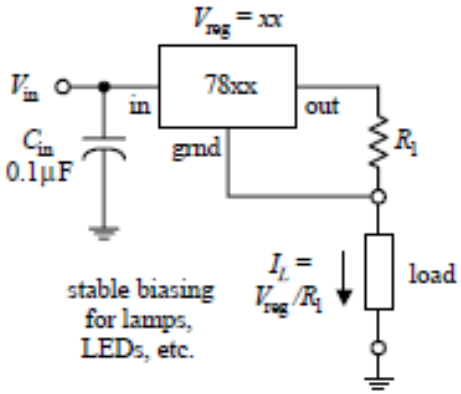
FIGURE 10.5

Applications

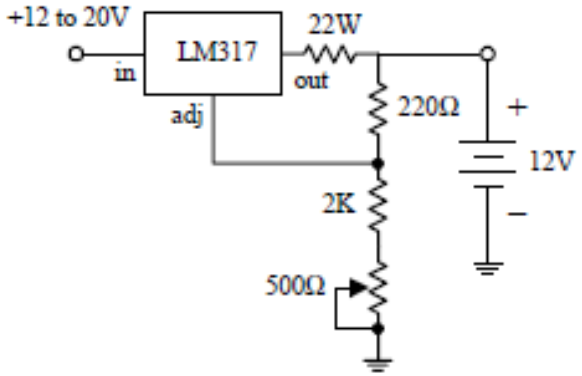
Car battery voltage regulation



Current regulator

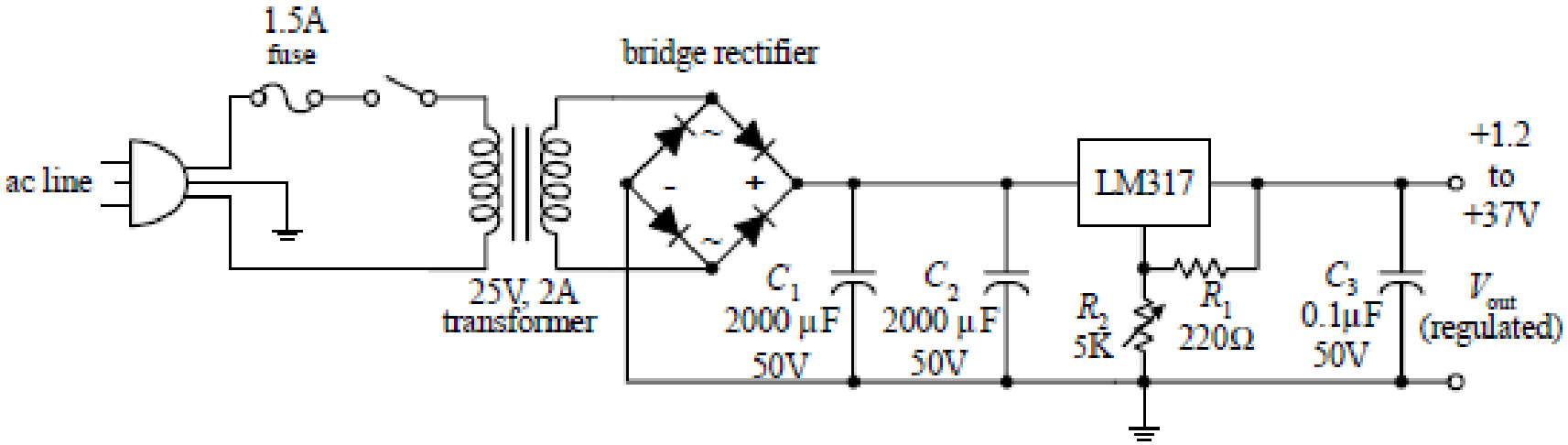


12V battery recharger



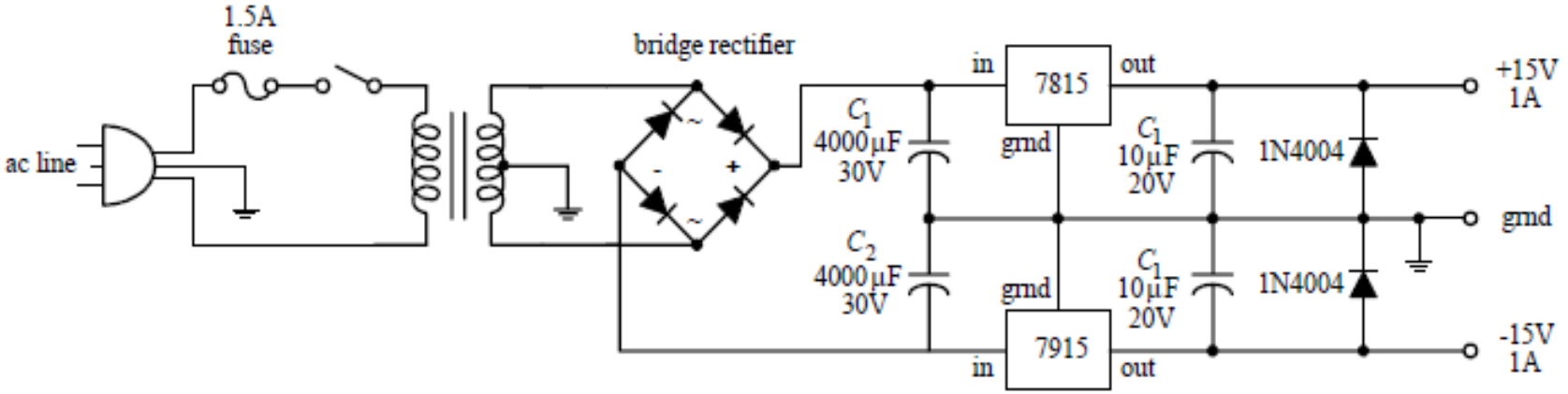
Power Supplies

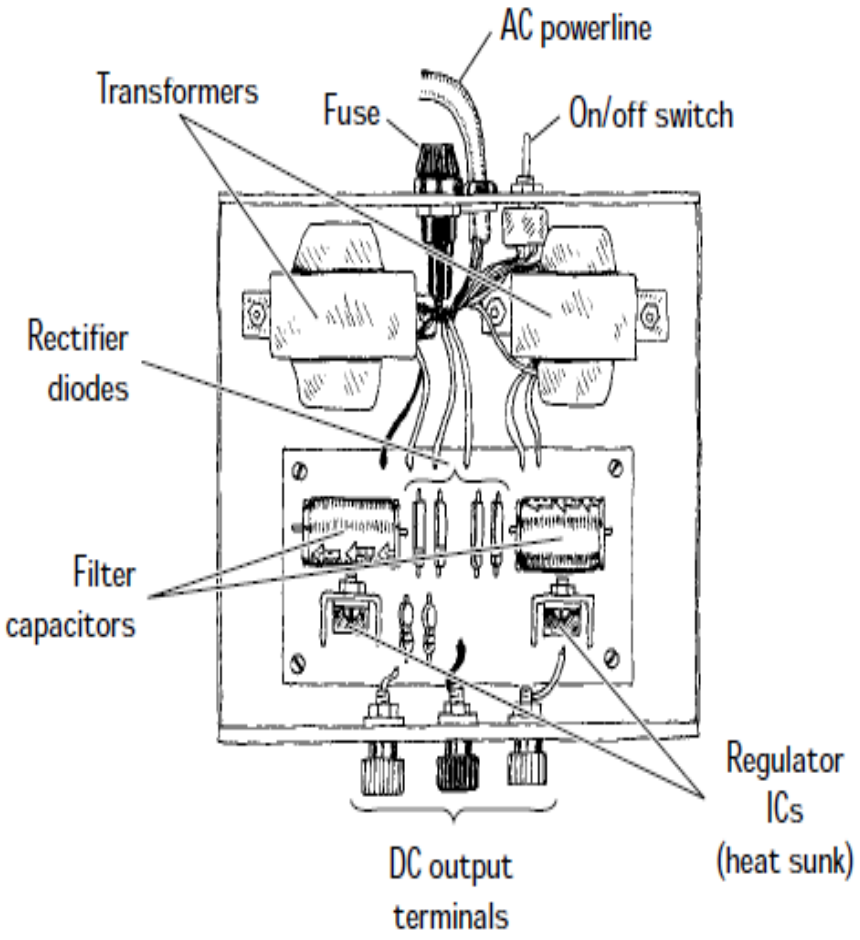
Adjustable +1.2- to +37-V, 1.5-A Supply



Applications of Power Supplies

±12-V and ±15-V Power Supplies





Build Your Own Power Supply

- Mount the transformer directly to the metal enclosure box, toward the rear.
- Install fuses, power switch, and binding posts at the rear of the box.
- Mount circuit boards on standoffs within the box.
- Place diode or rectifier modules, along with the capacitors and voltage regulators, on the circuit board.
- Make sure to heat-sink voltage regulators.
- Place supply output jacks on the front of the box.
- Drill holes in box to allow cooling.
- Ground the box.
- Place the power-line core through a hole in the rear. Use a rubber grommet for strain relief.
- To avoid shocks, make sure to insulate all exposed 120-V power connections inside the box with heat-shrink tubing.

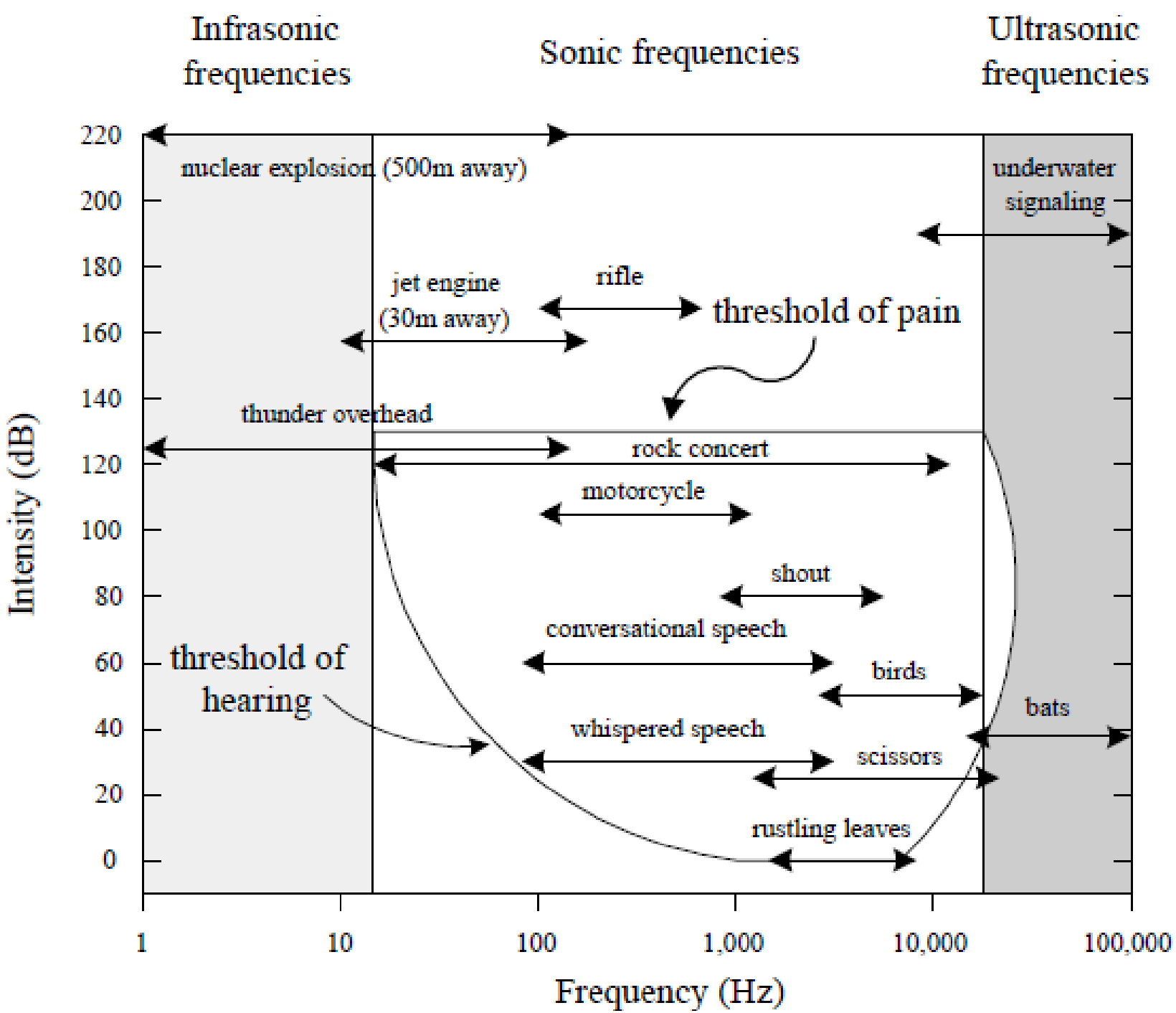
Audio Electronics

Nature of Sound

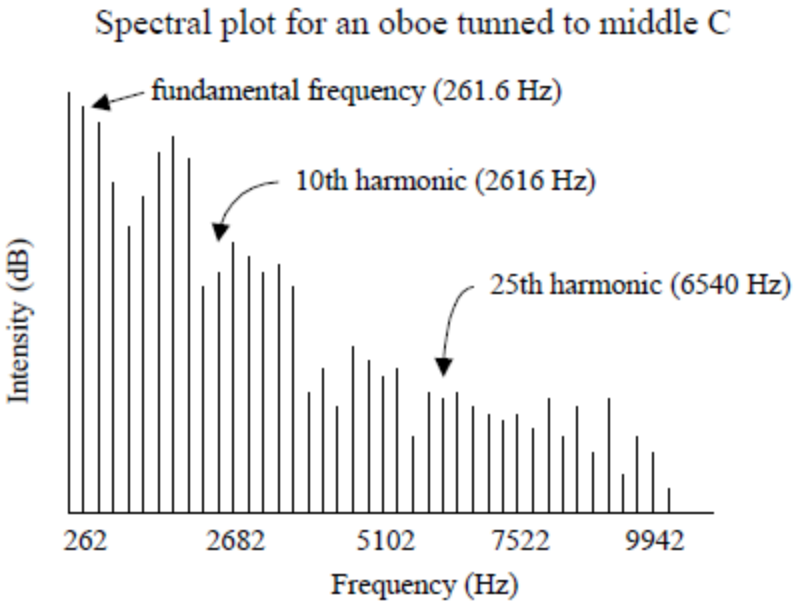
- Frequency
- Intensity (loudness)
- Timbre (overtones)

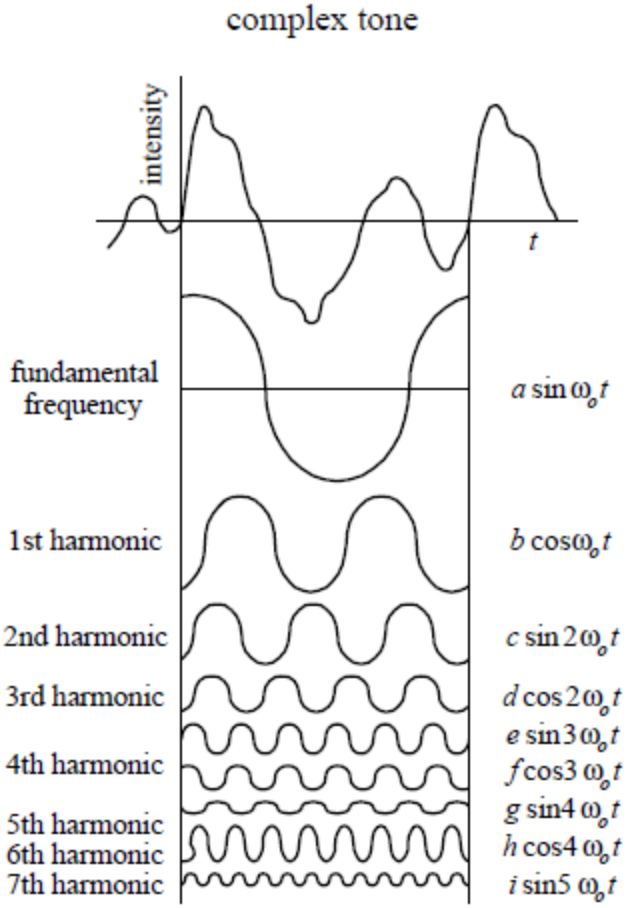
Frequency: Human Ear can perceive frequencies from 20-25000Hz, however ear most sensitive in the range 1000-2000Hz

Intensity : from 10^{-12} to $1\ \mathrm{W/m^2}$ i.e., from 0-120dB

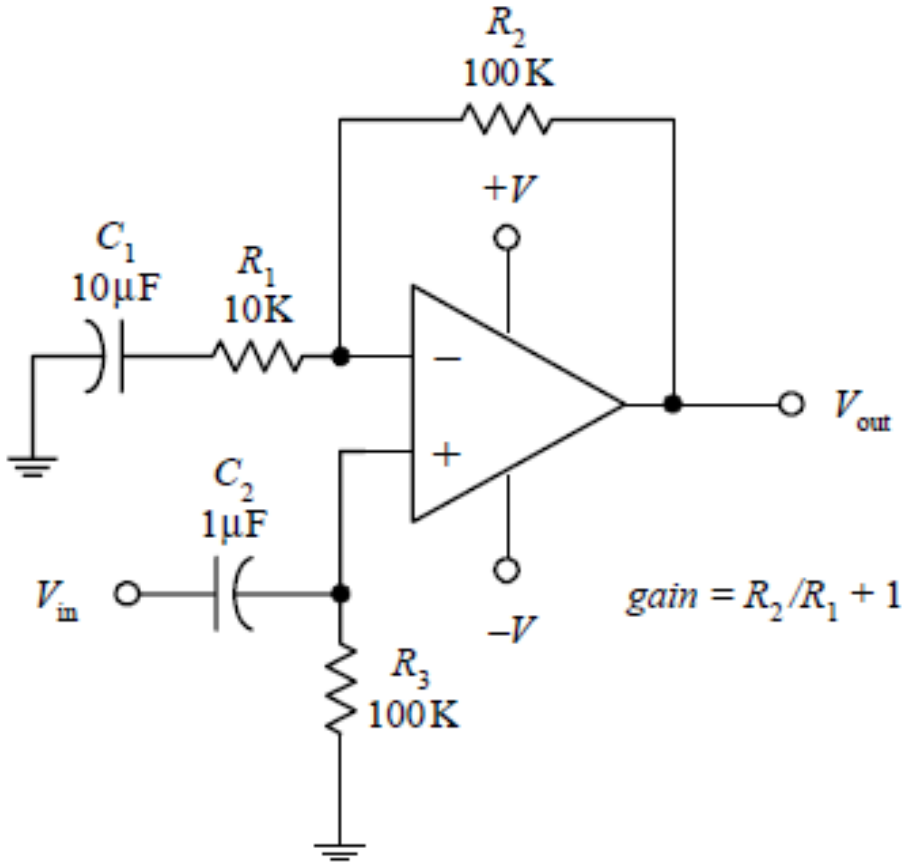

Infrasonic frequencies
Sonic frequencies
Ultrasonic frequencies
220
200
180
160
140
120
100
80
60
40
20
0
Intensity (dB)
nuclear explosion (500m away)
underwater signaling
jet engine (30m away)
rifle
threshold of pain
thunder overhead
rock concert
motorcycle
shout
conversational speech
threshold of hearing
birds
bats
whispered speech
scissors
rustling leaves
1
10
100
1,000
10,000
100,000
Frequency (Hz)

Timbre

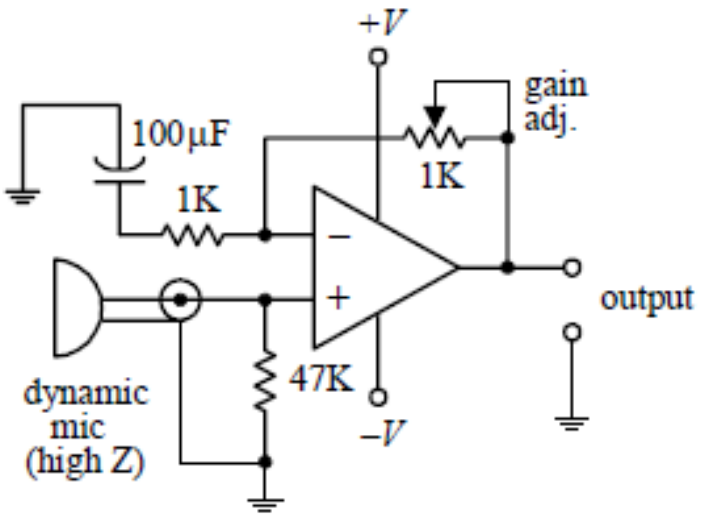

Spectral plot for an oboe tunned to middle C
fundamental frequency (261.6 Hz)
10th harmonic (2616 Hz)
25th harmonic (6540 Hz)
Intensity (dB)
262
2682
5102
7522
9942
Frequency (Hz)

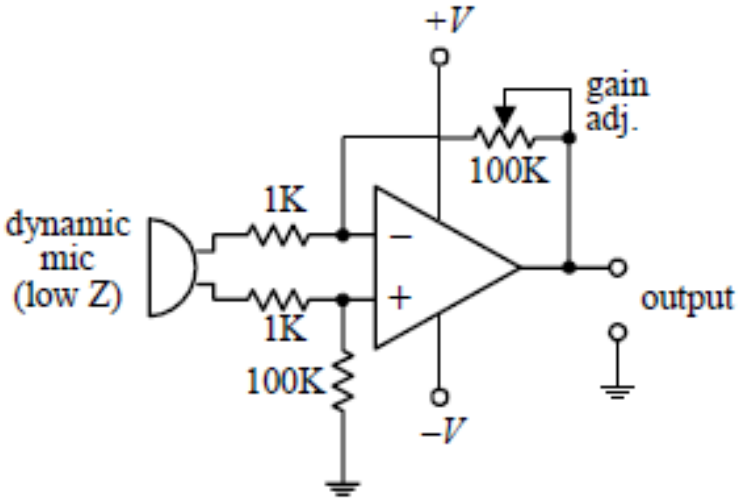

complex tone
intensity
t
fundamental frequency
a sin ω0t
1st harmonic
b cosω0t
2nd harmonic
c sin 2ω0t
3rd harmonic
d cos 2ω0t
e sin 3ω0t
4th harmonic
f cos3 ω0t
g sin4 ω0t
5th harmonic
6th harmonic
h cos4 ω0t
7th harmonic
i sin5 ω0t

Audio Amplifier

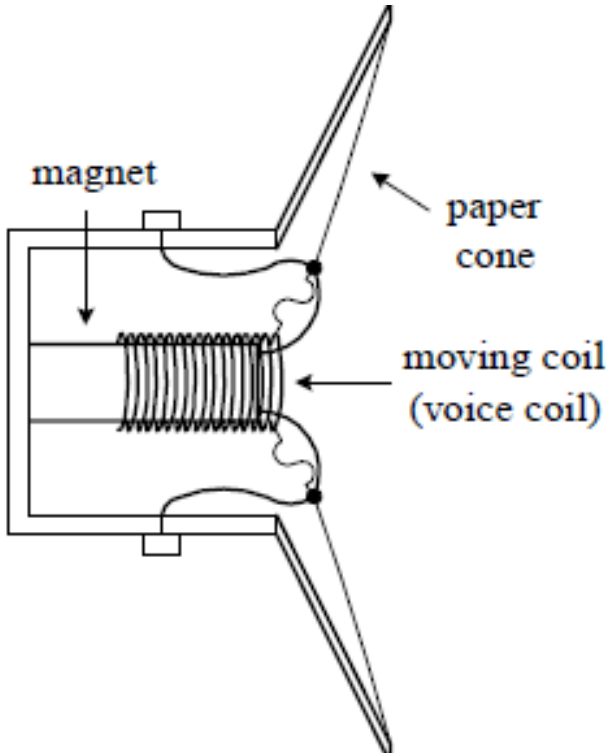


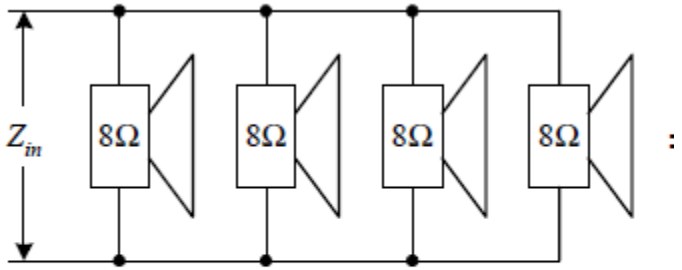
Preamplifier





Speakers





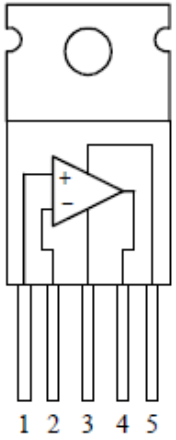
$$\frac{1}{Z_{eq}} = \frac{1}{8\Omega} + \frac{1}{8\Omega} + \frac{1}{8\Omega} + \frac{1}{8\Omega}$$

$$Z_{eq} = 2\Omega$$

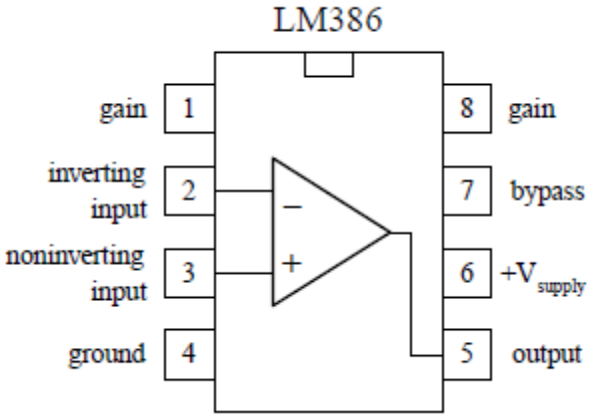
Speakers convert electrical signals in audible signals. The most popular speaker used today is the dynamic speaker. The dynamic speaker operates on the same basic principle as a dynamic microphone. When a fluctuating current is applied through a moving coil (voice coil) that surrounds a magnet (or that is surrounded by a magnet), the coil is forced back and forth (Faraday's law). A large paper cone attached to the coil responds to the back-and-forth motion by "drumming off" sound waves.

Audio Amplifier

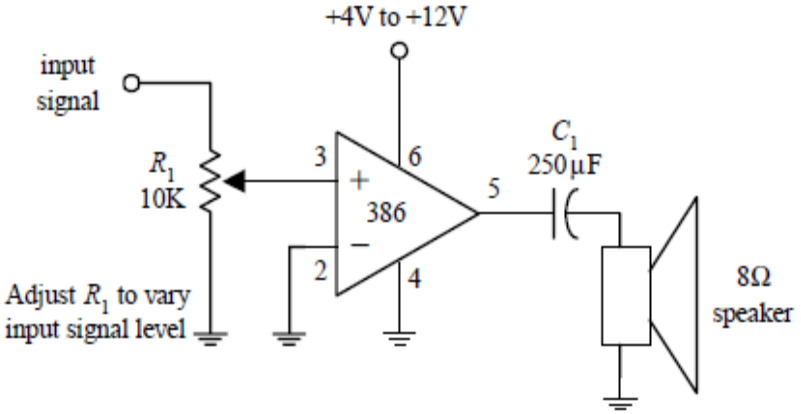
Audio Amplifier (LM383)



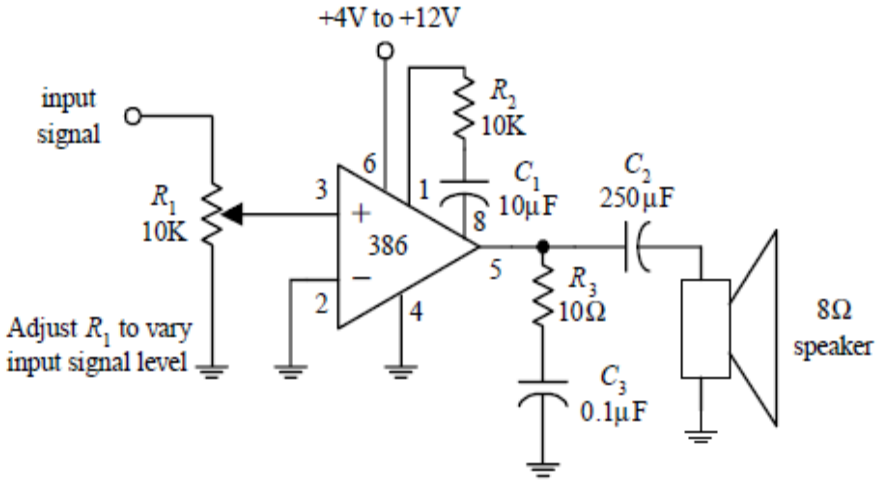
1 = noninverting input
2= inverting input
3 = ground
4 = output
5 = supply voltage



Audio amplifier (gain of 20)

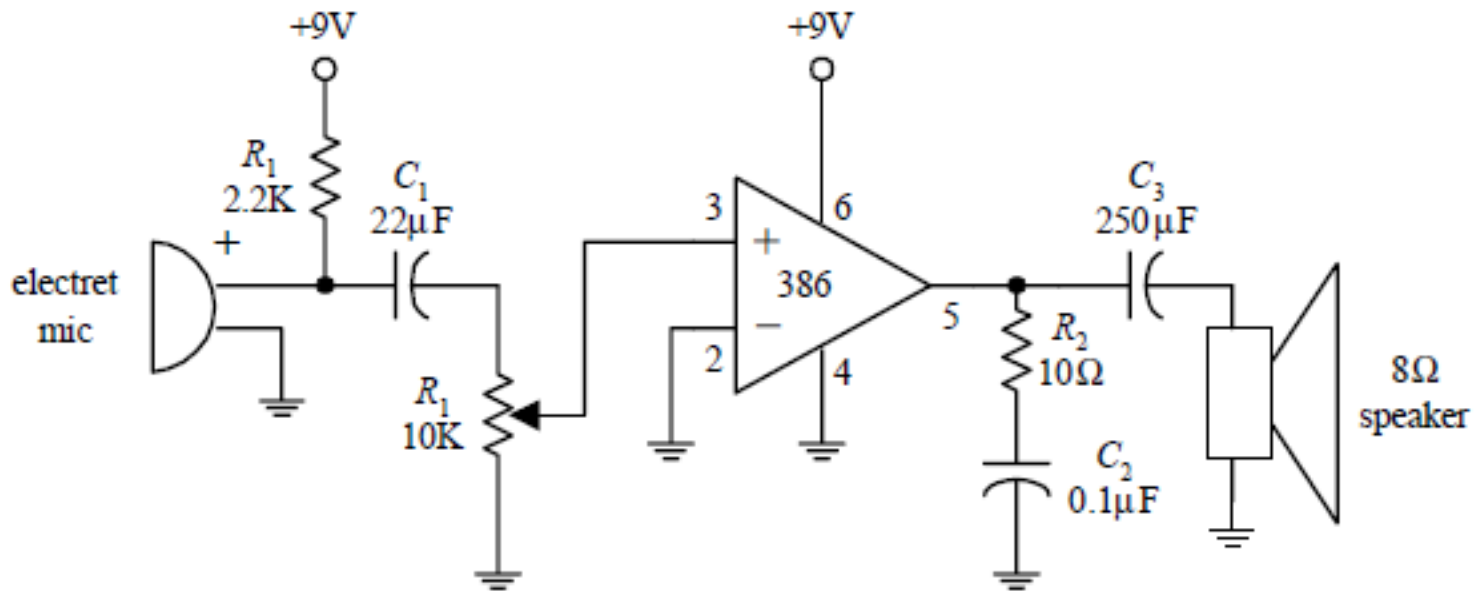


Audio amplifier (gain of 200)

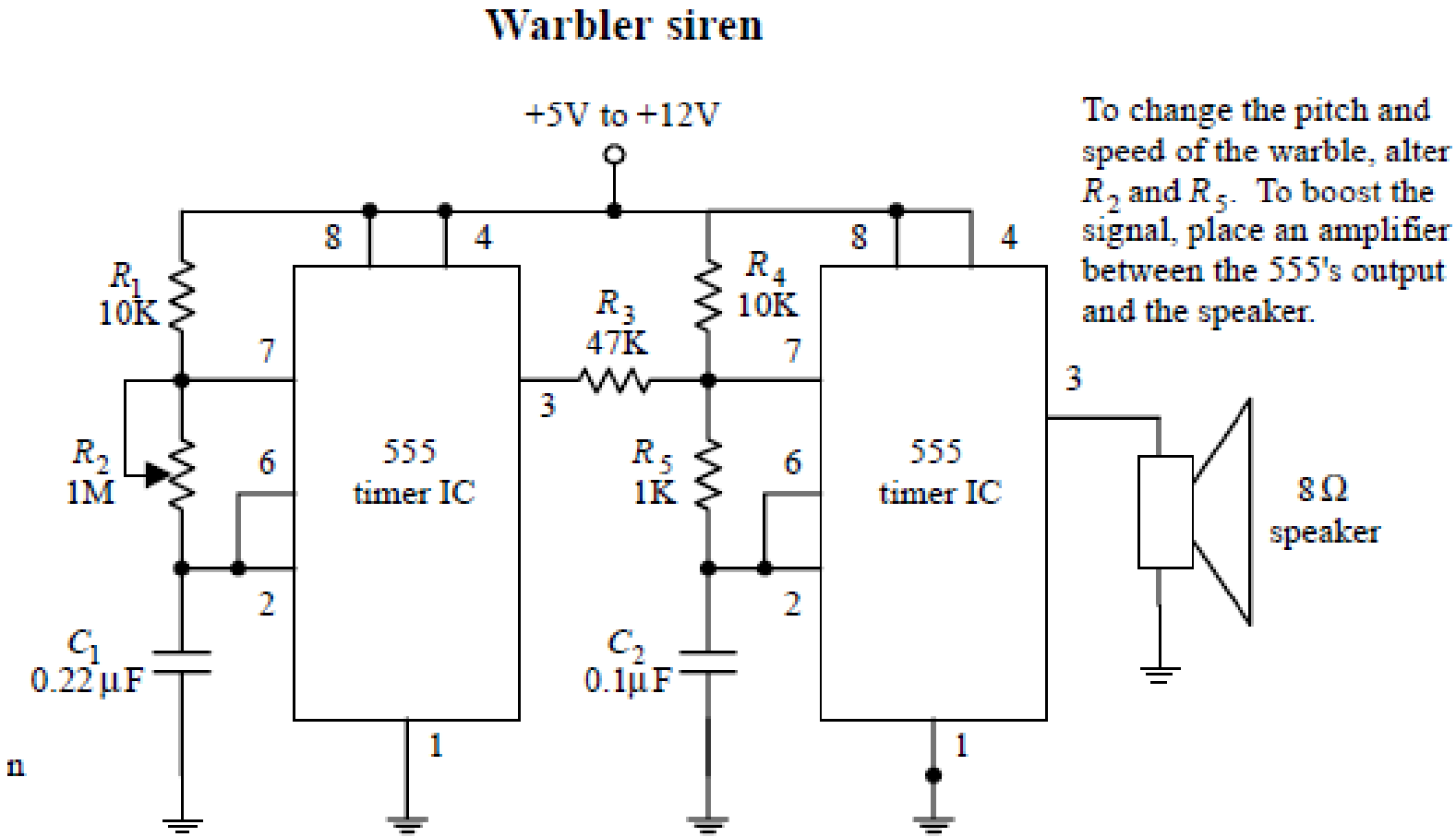


Applications

Megaphone



Applications



Applications

Sound-Activated Switch