



Hearing & Seeing Alternating Current (AC)



Edison's name will always be associated with the development of the incandescent bulb but he spent as much time developing DC (direct current) generators and electrical distribution systems. He had as opposition to his DC transmission plans the formidable Westinghouse and his own assistant, Nikola Tesla - both backing the production of AC (alternating current) for the distribution of electrical power.

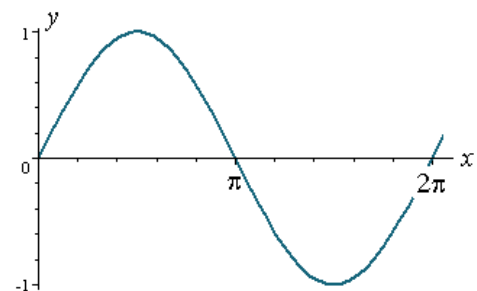
Edison waged a "War on Currents" to prevent AC from being adopted. He developed the 'electric chair' and his employees publicly electrocuted animals to convince authorities that AC can be lethal to humans. But alas - today most of our electrical equipment are powered by AC due to AC transmission being cheaper and much more effective.

Light produced by a bulb lit with DC or AC looks similar to the human eye. But the reality is that the AC bulb is flickering at such a rate that the human eye can't detect it. This article is about two simple demonstrations (without chemicals) that will make AC light audible and visible!

Have a look at the roof lights mounted above you. Can you see the lights flickering at a fast rate? No - you won't be able. The human eye can detect rates of 20 to 25 flickers per second at its best. And how fast are our lights flickering?
An astonishing **100 times a second!**

Power station generators in Australia & New Zealand produce alternating current (ac) at 50 Hz. This simply means that the current goes through 50 **cycles** per second. One cycle is depicted on the right. Where the 'wave' crosses the line, the current is momentarily off, so this happens twice per cycle or 100 times per second.

Now - how can you demonstrate this? Spinning an ac connected neon lamp in a circular path on a cord only demonstrates **intermittent** current, not **alternating** current.



And here are the secrets:

1. The human ear can easily detect high frequencies, so when you convert a lamp's output to an **audible signal**, then one can detect the alternating current.
2. By using a **bi-colour LED** and connecting it to an AC source, you can demonstrate the change in current direction as well as the intermittent switching*.

A bi-colour LED has two LEDs wired in 'inverse parallel' combined in one package with two leads. Only one of the LEDs can be lit at one time and this is dependent on the current flow **direction**.

Components

Hearing AC

- ★ Solar panel (ours has an output of 1V; 350 mA but any type will do).
- ★ Amplified speaker (with the growth in popularity of iPods these now come in various formats. Make sure you use one with at least 1W output and with a 3.5 mm input socket. Amplified computer speakers should do the job too).
- ★ Speaker flex cable (light duty, figure 8).
- ★ 3.5 mm stereo plug to connect the cable to the speaker.
- ★ Flashlight powered by batteries.



Seeing AC

- ★ Bi-colour LED
- ★ Resistor: 200 to 400 ohm; 0.25 Watt
- ★ Speaker flex cable (light duty, figure 8)
- ★ AC adaptor (240V AC, 50Hz to 6, 9 or 12 V AC)



Putting it together

Hearing AC

Simply connect the solar panel to the amplified speaker using the 3.5 mm stereo plug and cable. It is best to solder the cable wires to the plug.

Switch off the room lights, turn the amplified speaker to maximum volume, point the solar panel at the roof and then turn the lights on. (You should hear a 100 Hz buzzing sound. The sound of alternating current!)

Switch off the lights, turn on the flashlight and point it at the solar panel to emphasize the dc / ac difference. By intermittently breaking the light beam with your fingers, you can create a clicking sound on the speaker.

Now, with the lights off, move the solar panel to a TV screen and / or computer monitor. You should clearly hear the changed flickering rate. Cathode ray tube monitors (CRT) - the thicker, older monitors - will have a more audible output than flat screen monitors (LCD).

Seeing AC

1. Solder the resistor to one of the LED's terminals.
2. Solder the cable to the resistor and other LED terminal.
3. Connect the cable to the adaptor's output wire.
4. Insulate the LED's terminals so they do not touch. *We have glued ours down onto a piece of plexiglass (free from a plastics shop) using epoxy glue.*



Make sure you use an **ac** adaptor and **never** connect an LED to the AC mains supply!

Which **resistor** should be used in series with the LED?

With 6V use a 200 ohm; 9V use a 300 ohm; 12V use a 400 ohm

First demonstrate the two colours of the LED with direct current (DC) by touching a battery to the resistor and LED terminal. Then plug in the ac adaptor and dim the lights. Both LEDs should be flickering at a 100 Hz rate. Now slowly swing the LED in a (vertical) circular path. You should be able to see dark areas (current turned off) and areas of different colour indicating a change in current direction.

Safety: Stand clear of objects and people when swinging the LED.

Extension



The RGB Ball in our web shop has three fast flickering red, green & blue LEDs. Together they create a 'white' colour impression in our brains. The human eye cannot detect the flickering in the stationary ball but placing the ball close to the solar panel makes the switching **audible**. Also - if you view the ball in a mirror (an old CD works well) and wiggle the mirror, then the three colours become **visible**. Amazing!

Flicker in computer monitors

Humans can perceive lights flickering up to 25 Hz. Even though not perceptible, flicker at much higher frequencies affects people by causing eyestrain and migraines. Computer monitor flicker particularly affects people in the autism spectrum including people with Asperger's Syndrome.

In monitors based on CRT technology (cathode ray tube), the refresh rate (usually 60 or 72 Hz) is the number of times that the image on the display is re-freshed each second. Flat panel (LCD) displays are not significantly affected by this as LCD displays turn each pixel off individually so they do not produce a flicker like CRT displays do.

References:

* The bi-coloured LED was first demonstrated to us by Al Guenther at the 2009 NSTA Conference in New Orleans, USA