EMBEDDED SYSTEMS AND KINETIC ART:

ALTERNATING CURRENT + ARDUINO

What is Alternating Current?

The first alternator to produce alternating current was a dynamo electric generator based on Michael Faraday's principles constructed by the French instrument maker Hippolyte Pixii in 1832. Pixii later added a commutator to his device to produce the (then) more commonly used direct current. The earliest recorded practical application of alternating current is by Guillaume Duchenne, inventor and developer of electrotherapy. In 1855, he announced that AC was superior to direct current for electrotherapeutic triggering of muscle contractions.

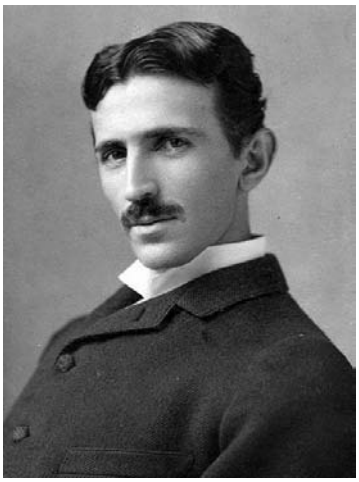
Alternating current technology had first developed in Europe due to the work of Guillaume Duchenne (1850s), The Hungarian Ganz Works (1870s), Sebastian Ziani de Ferranti (1880s), Lucien Gaulard, and Galileo Ferraris.

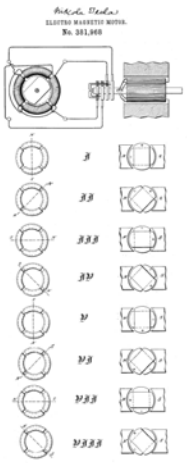
In 1876, Russian engineer Pavel Yablochkov invented a lighting system based on a set of induction coils where the primary windings were connected to a source of AC. The secondary windings could be connected to several 'electric candles' (arc lamps) of his own design. The coils Yablochkov employed functioned essentially as transformers.

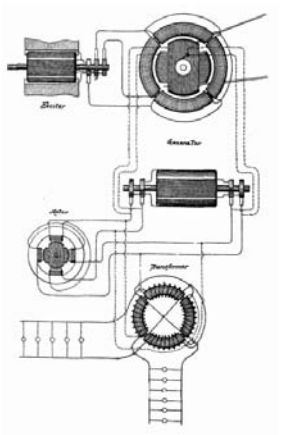
In 1878, the Ganz factory, Budapest, Hungary, began manufacturing equipment for electric lighting and, by 1883, had installed over fifty systems in Austria-Hungary. Their AC systems used arc and incandescent lamps, generators, and other equipment.

A power transformer developed by Lucien Gaulard and John Dixon Gibbs was demonstrated in London in 1881, and attracted the interest of Westinghouse. They also exhibited the invention in Turin in 1884.

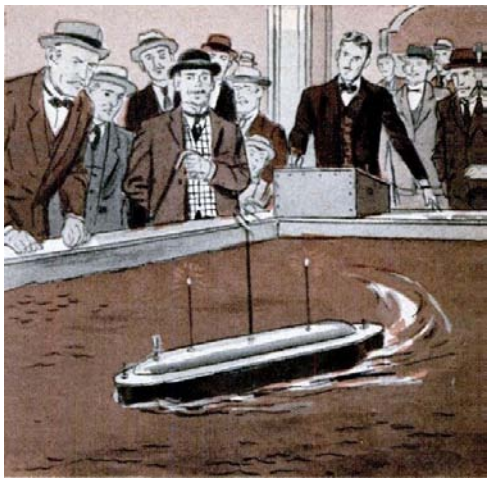
Nikola Tesla

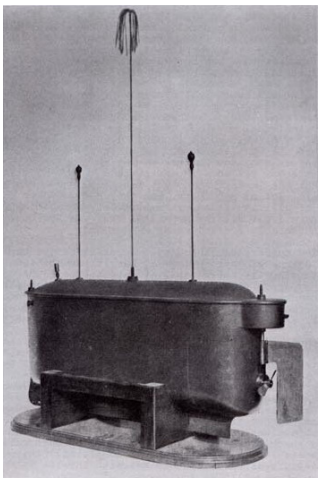




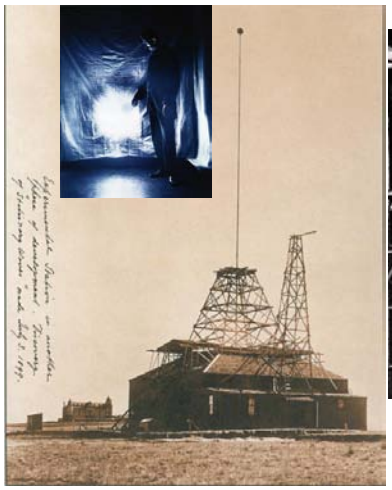


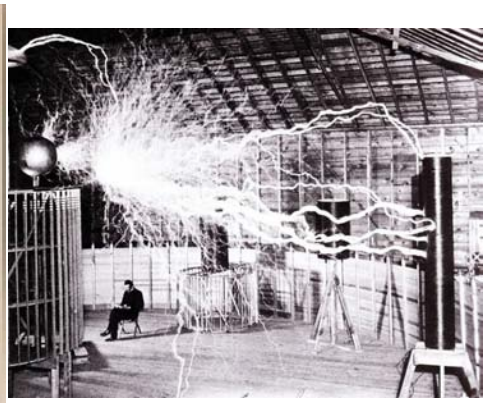
Nikola Tesla



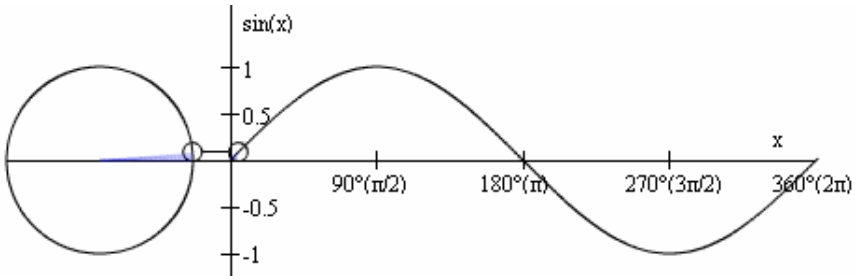


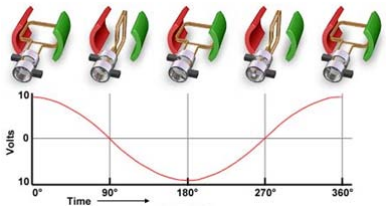
Nikola Tesla



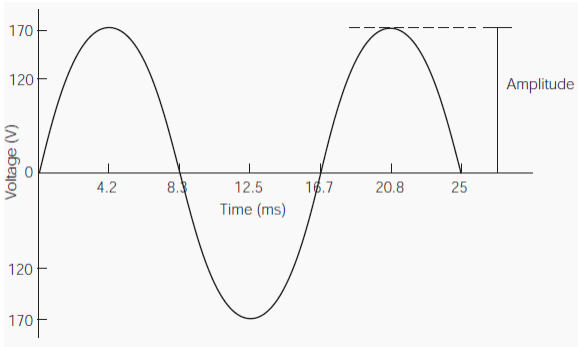


Wave and Amplitude





Sine Wave

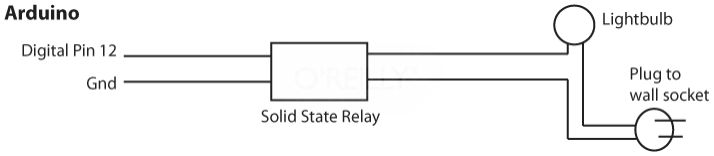


Dangers of AC and High Voltage

- 1. Beware of lightning that lurketh in an uncharged condenser lest it cause thee to bounce upon thy buttocks in a most embarrassing manner
- 2. Cause thou the switch that supplieth large quantities of juice to be opened and thusly tagged, that thy days may be long in this earthly vale of tears.
- 3. Prove to thyself that all circuits that radiateth, and upon which thy worketh, are grounded and thusly tagged lest they lift thee to a radio frequency potential and causeth thee to make like a radiator, too.
- 4. Tarry thou not amongst these fools that engage in intentional shocks for they are not long for this world and are surely unbelievers.
- 5. Take care that thou useth the proper method when thou takest the measures of high-voltage circuits, that thou dost not incinerate both thee and thy test meter, for verily, though thou has no company property number and can be easily replaced, the test meter has one and, as a consquence, the loss of which bringeth much woe unto a purchasing agent.
- 6. Take care that thou tamperest not with interlocks and safety devices, for this incurreth the wrath of the chief electrician and bring the fury of the engineers on his head.
- 7. Work thou not on energized equipment for if thou doest so, thy friends will surely be buying beers for thy widow and consoling her in certain ways not generally acceptable to thee.
- 8. Verily, verily I say unto thee, never service equipment alone, for electrical cooking is a slow process and thou might sizzle in thy own fat upon a hot circuit for hours on end before thy maker sees fit to end thy misery and drag thee into his fold.
- 9. Trifle thee not with radioactive tubes and substances lest thou commence to glow in the dark like a lightning bug, and thy wife be frustrated and have not further use for thee except for thy wages.
- 10. Commit thou to memory all the words of the prophets which are written down in thy Bible which is the National Electrical Code, and giveth out with the straight dope and consoleth thee when thou hast been suffered upon by thy chief electrician

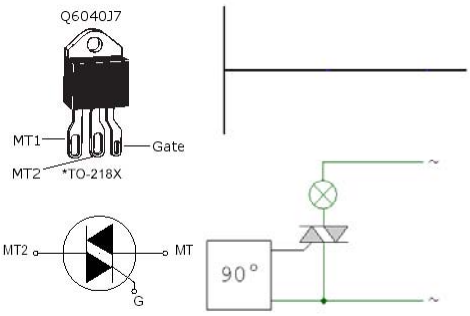
Methods of control

- Solid State Relay
- Driven like an LED
- Can switch massive AC loads
- Cannot be dimmed without additional hhardware



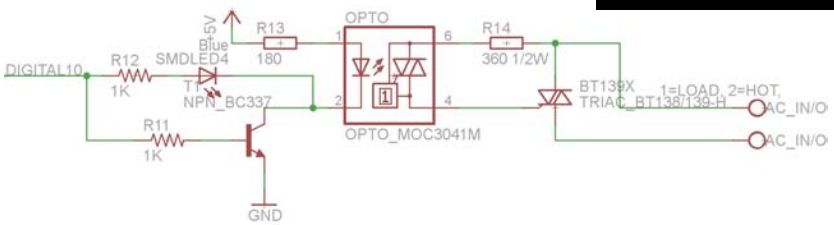
Methods of control

- Triac
- Like a transistor fo AC
- Needs to be isolated from the Arduino



Methods of control

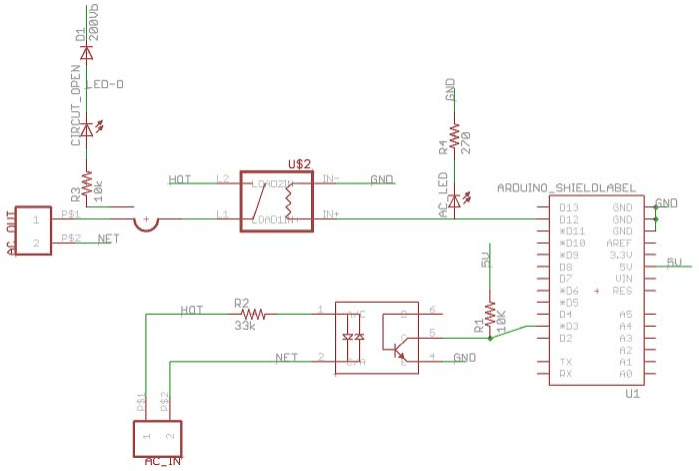
Isolated using an opto – isolator which is a combination of an infrared led and phototransistor within an IC package



Methods of control

- Triac Continued
- A properly wired circuit is capable of dimming- called phase control
- Works like PWM but does not use the PWM command
- Info here: http://playground.arduino.cc/Code/ACPhaseControl#.UzSVmdFOVhw
- Uses an Interrupt

Wiring of Triac



- http://www.youtube.com/watch?v=ztXRjyCQxlE

Silicon Controlled Rectifiers

- **How SCRs Function**
- Unlike transistors, which may show an exponentially varying output current pattern, equivalent to the applied input switching current, SCRs have specific triggering levels below which they may not conduct properly. However, once the trigger level crosses the optimal value, an SCR may swing into full conduction.
- Another typical property associated with SCRs is their "latching" behavior with DC operated loads, where the anode to cathode conduction through the load latches or "holds-on" even after the gate trigger is inhibited. However, with AC operated loads the above drawback, or rather benefit, is not available and the load is switched ON or OFF exactly in response to the switching of the SCR's gate triggers.