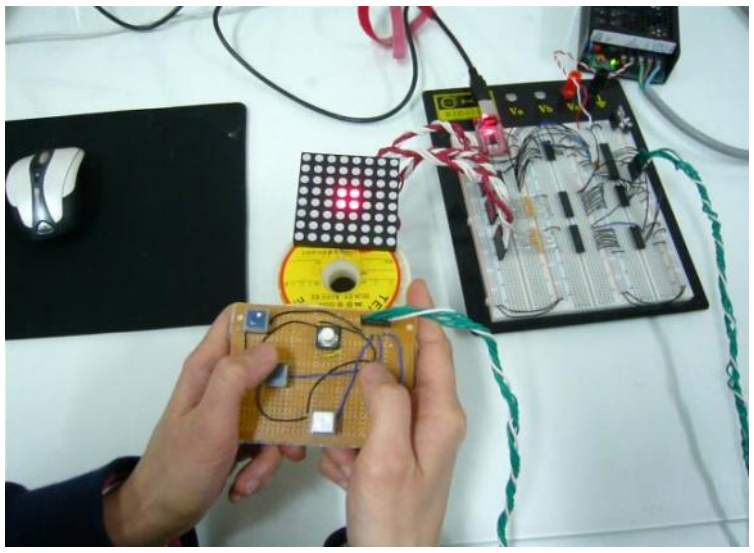
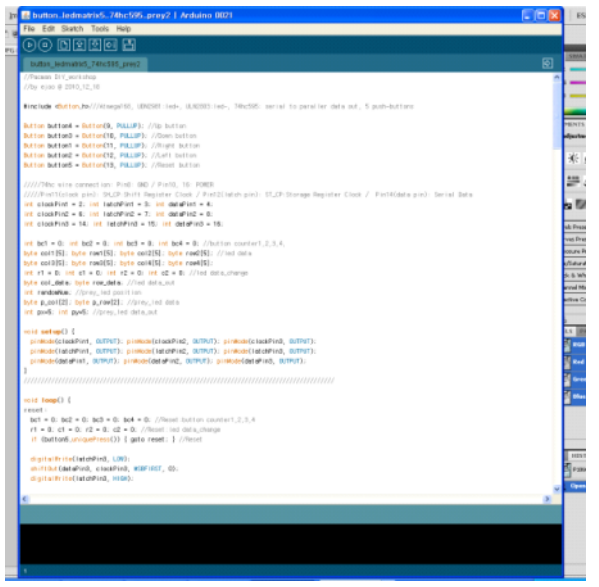
Board_1

Packman Workshop @MzTek _by EunJoo, Shin

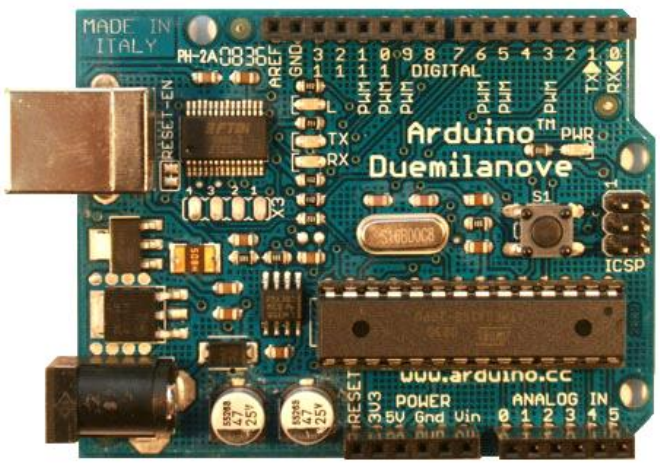
1. What's a basic set up to control a hardware-built circuit ?





1. Inputs: 4 momentary switches
2. Chips to control: - MicroController: Atmega 168
   - LED matrix driving ICs : 74HC595, UDN2981, ULN2803
3. Output: LED matrix : RED (8X8 = 64) + Green(8X8 = 64) ==> total 128 LEDs
4. Computer-Coding: Arduino Software
5. Debugging: by software or by hardware

2. Arduino board VS Armega 168 (micro-Controller)



Arduino : - pre -made board for mainly educational purpose
(students, artists, hobbyists)
- easy to use
http://www.arduino.cc/it/Main/ArduinoBoardDuemilanove

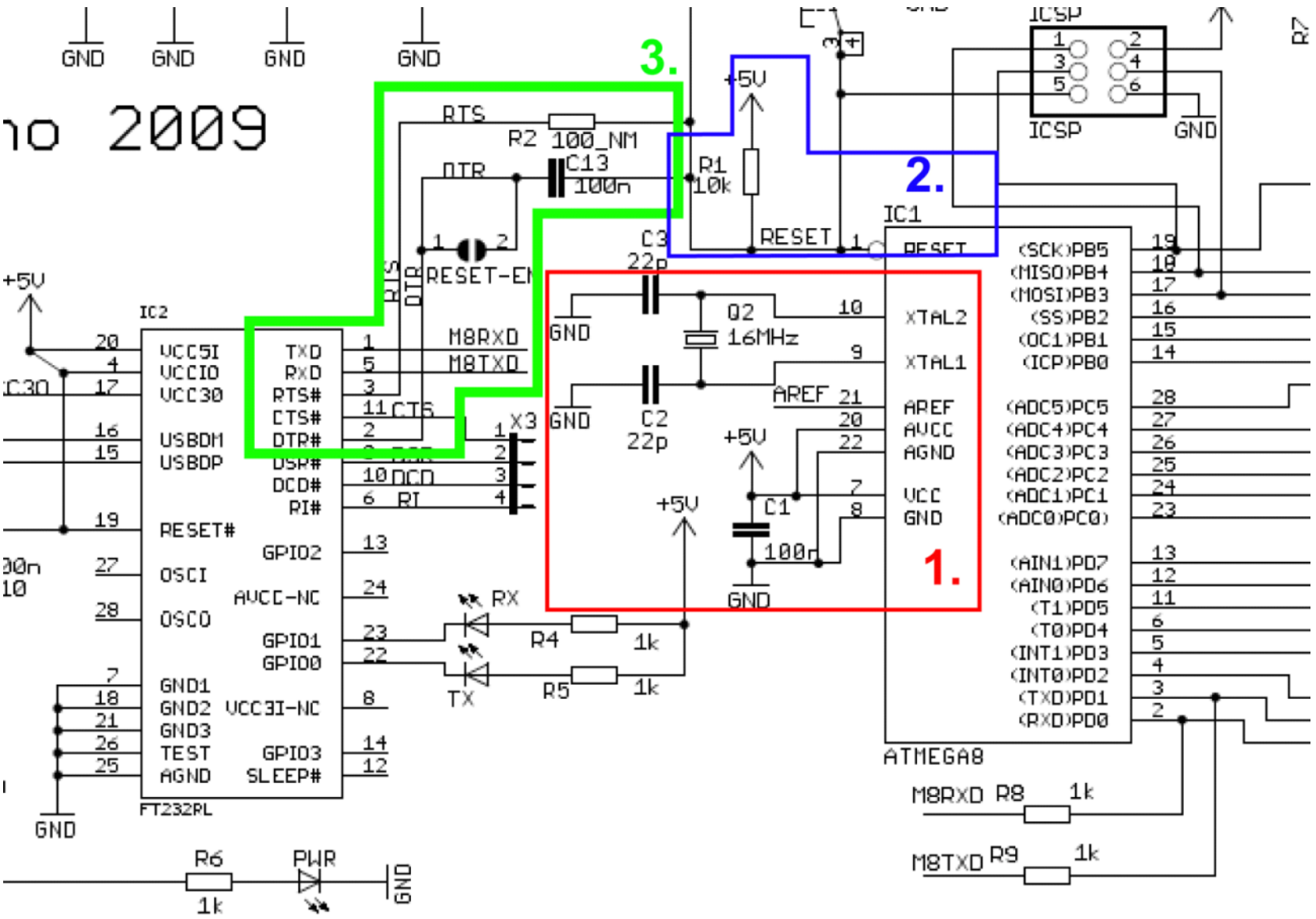
Atemga 168 PDIP (28 pins) : -for general engineering purpose
- not easy to use
(requiring to build a basic circuit)
http://www.atmel.com/dyn/products/product_card.asp?part_id=3303&category_id=163&family_id=607&subfamily_id=760

http://www.atmel.com/dyn/resources/prod_documents/doc2545.pdf

3. Can I build my own Arduino on a breadboard?

- **Tom Igoe's Physical Conputing blog @ ITP, NYU** http://itp.nyu.edu/physcomp/Tutorials/ArduinoBreadboard

- **Basic set up :** http://arduino.cc/en/uploads/Main/arduinoduemilanoveschematic.pdf

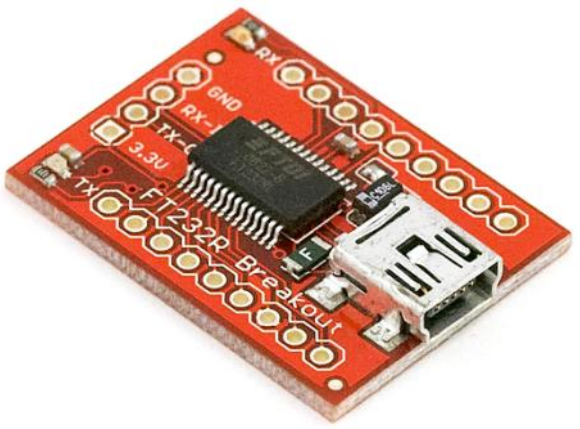


1 + **2** : Atmega168 set up

3 : USB to Serial (for downloading a code from a computer)
(for communicating between a micro-controller and a computer / TXD, RXD)

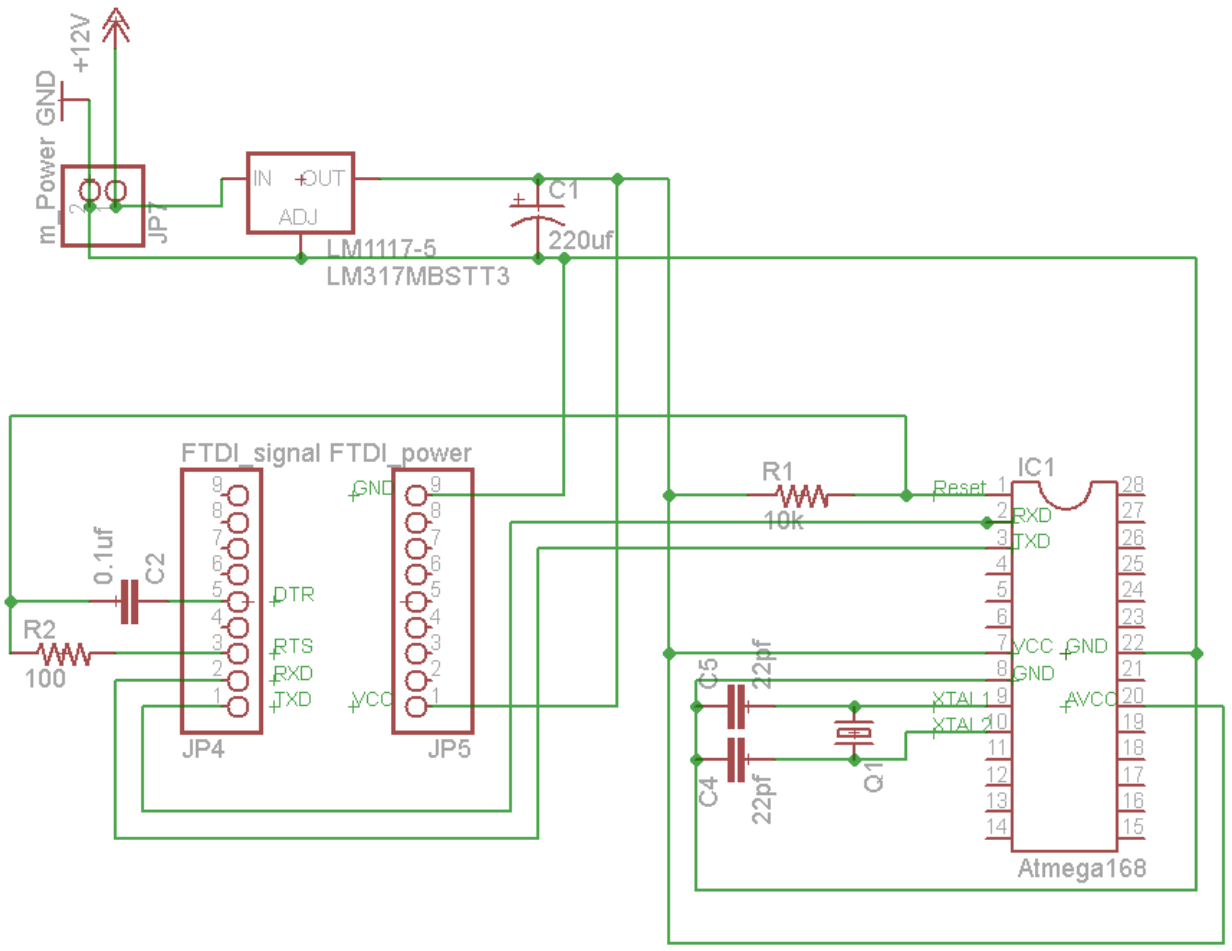
- **Basic breakout board for FTDI's popular USB to UART**

Avrmall: http://www.avrmall.com/ishop/goods_detail.php?goodsIdx=3782

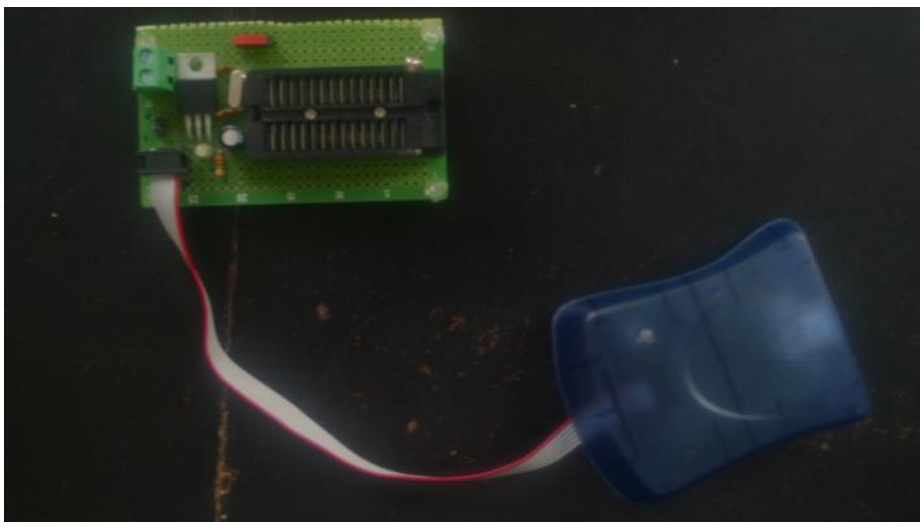


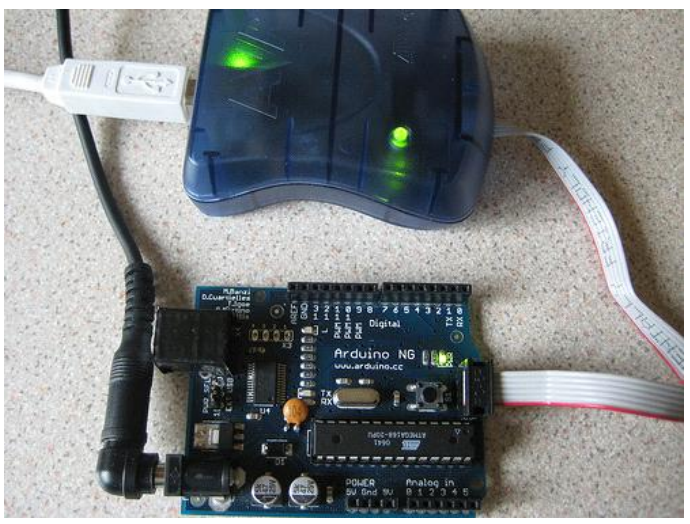
Sparkfun: http://www.sparkfun.com/products/718

- **Schematic of basic circuit set up**

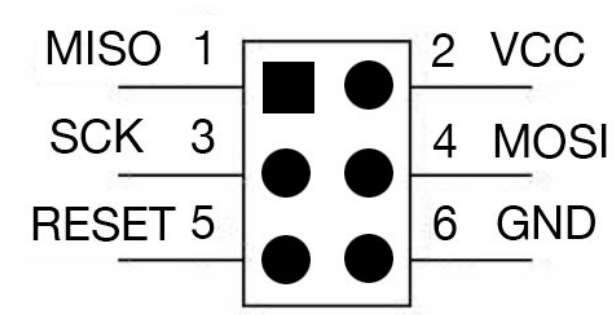


- **Download a bootloader file to Atmega 168 using a AVR ISP mkII programmer**
- **bootloader file ----->** C:\Program Files\arduino-0021\hardware\arduino\bootloaders\atmega
  choose and download ATmegaBOOT_168_diecimila.hex to a chip



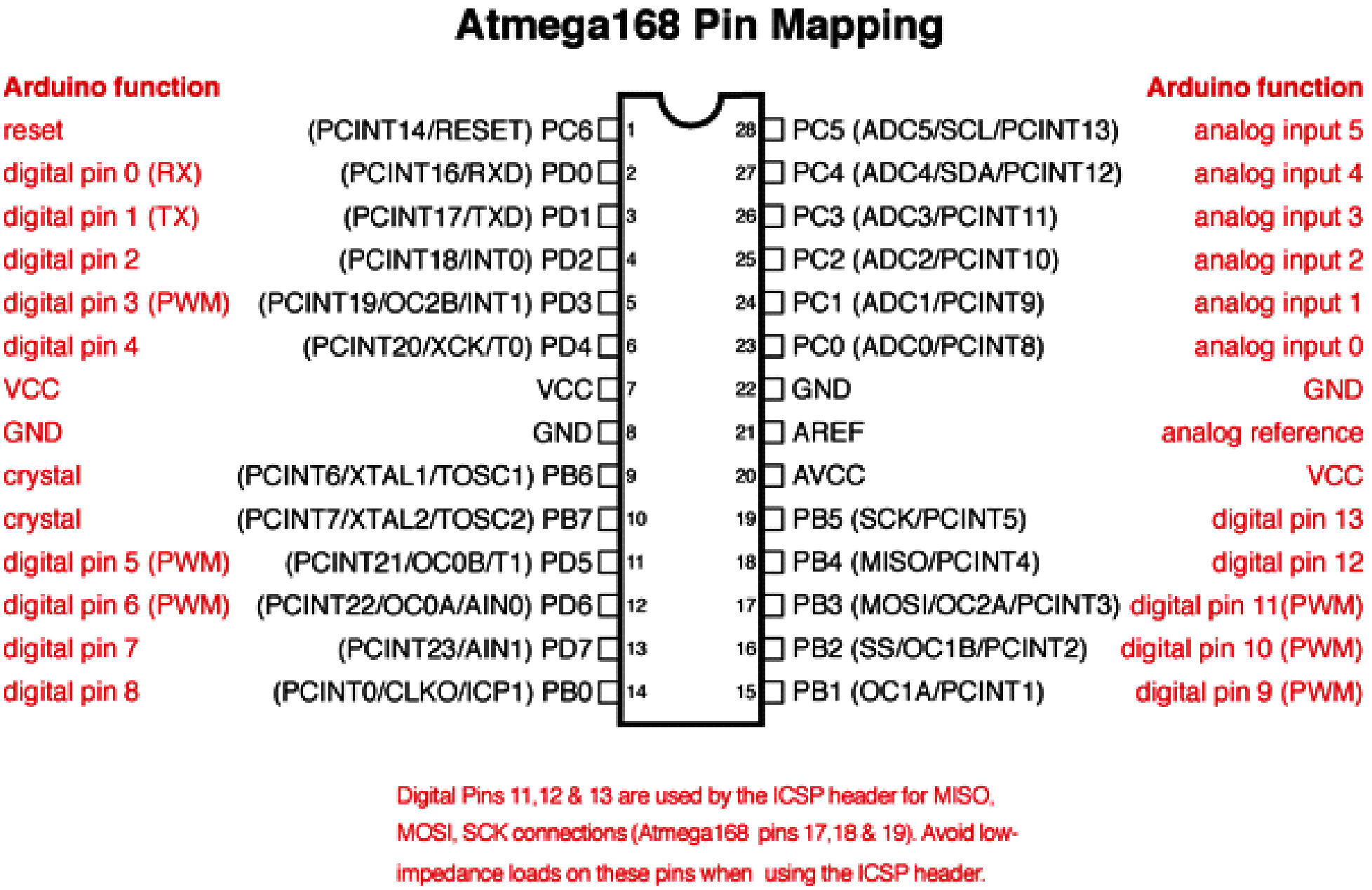


- **Where to buy a AVR ISP mkII programmer:**
  http://search.digikey.com/scripts/DkSearch/dksus.dll?Detail&name=ATAVRISP2-ND



- **Without AVR ISP mkII, buy a Atmega 328 with boot loader:**
  http://proto-pic.co.uk/products/ATmega328-with-Arduino-Bootloader.html

4. It's ready to use my own Arduino!!!



http://www.arduino.cc/en/Hacking/Atmega168Hardware

5. Let's look at Pacman Board

- **Part s' lists:**

1. FTDI Basic Breakout - 5V
2. Atmega168 X 1(Bootloader)
3. ULN2803 X 2
4. UDN2981 X 1: £2.15
5. 74HC595 X 1: £1.37
6. LED Matrix-Dual Color
7. Crystal 16.000MHz: £0.288
8. LM1117-5 (voltage regulator)
9. Resistors 100 Ω X 1 / 10K Ω X 1 / 470K Ω X 24
10. Capacitor 22pf X2 / 0.1uf X1 / 220uf X 1
11. USB Cable A to B - 6 Foot: £2.90
12. Switch X 5
13. Printed PCB board
14. Power supply (input: AC 100-250V
15. IC -sockets
16. Pin header, Pin socket

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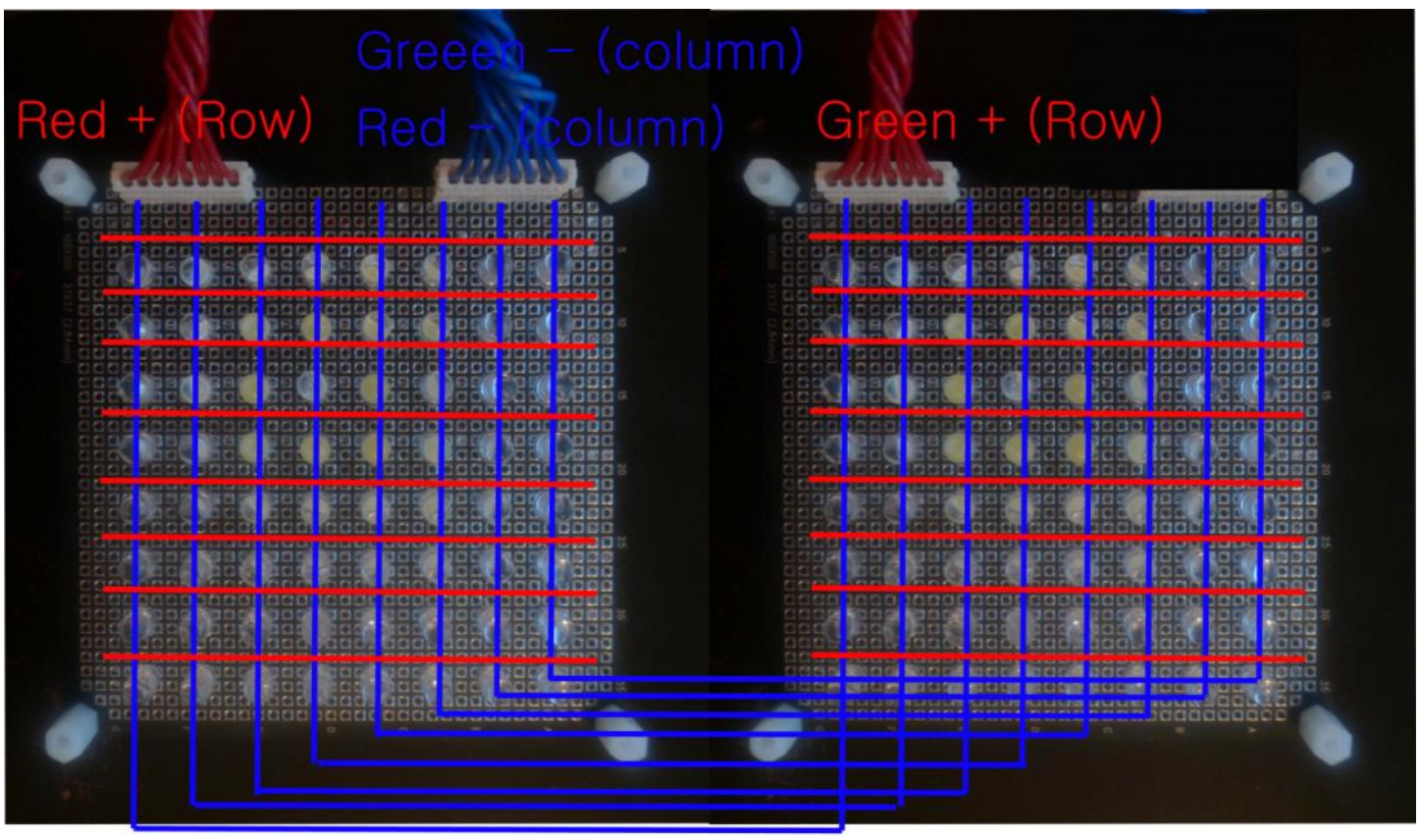
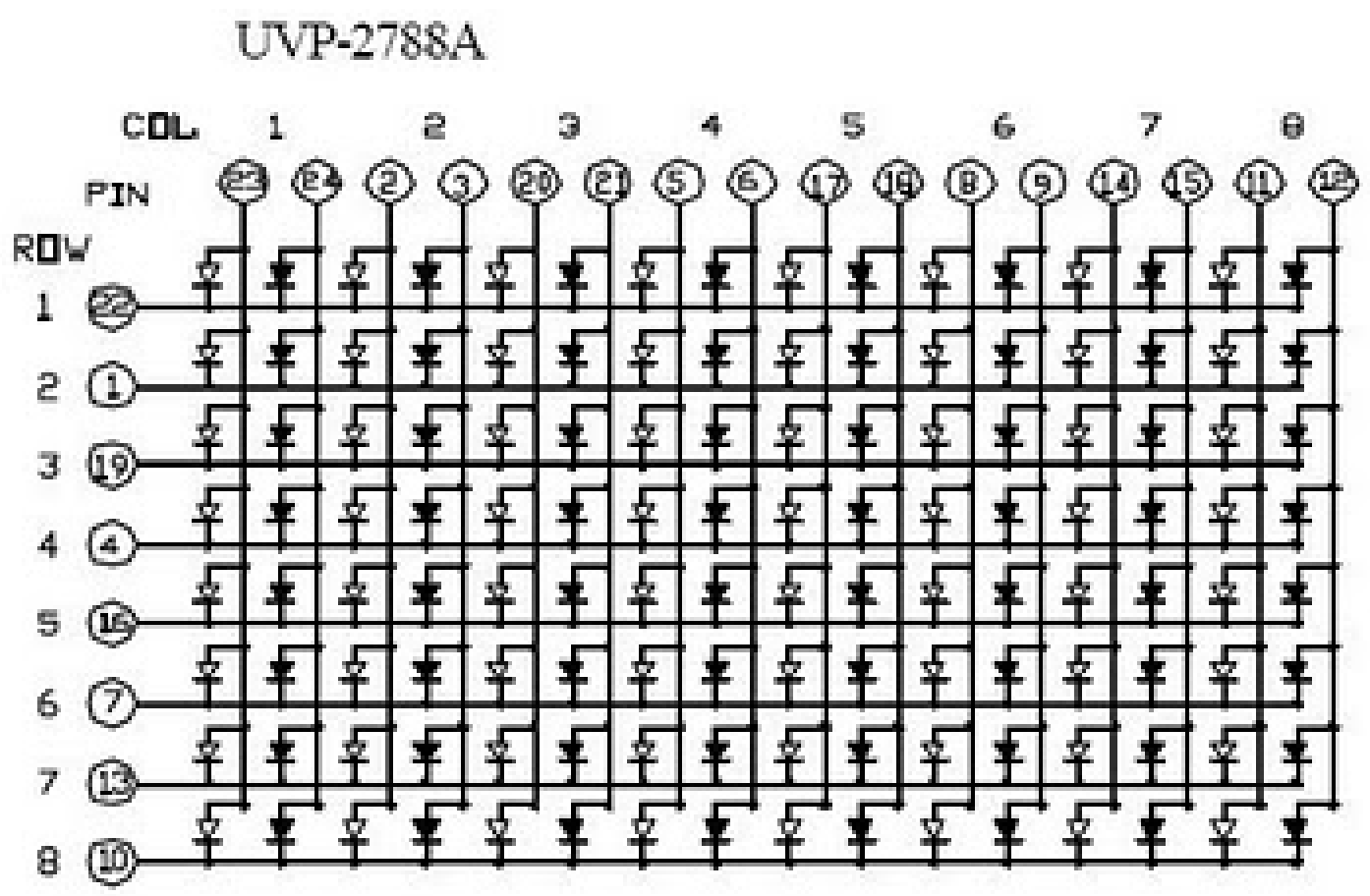
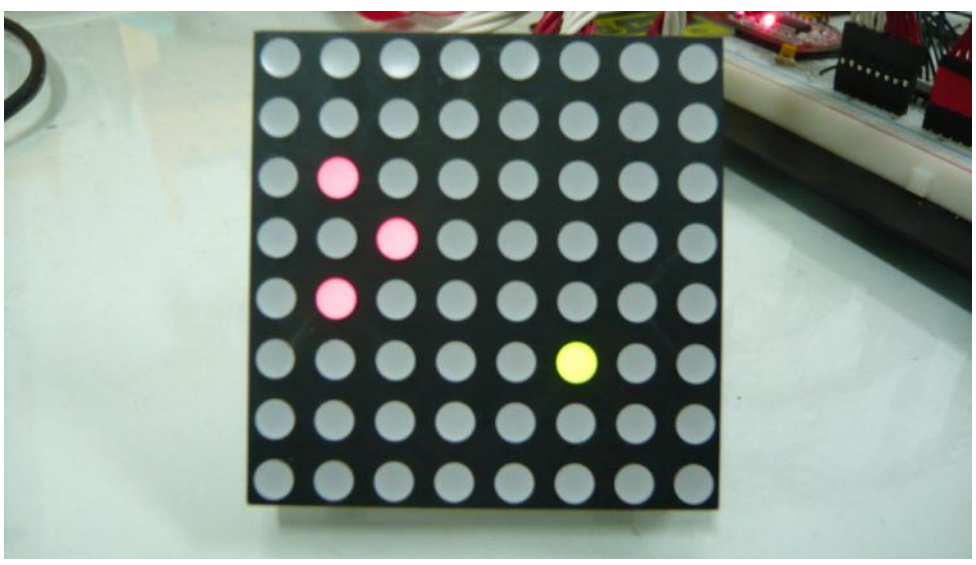
- **LED matrix:** Red color (8X8) + Green color (8X8) ====> 128 leds





Common GND Connection

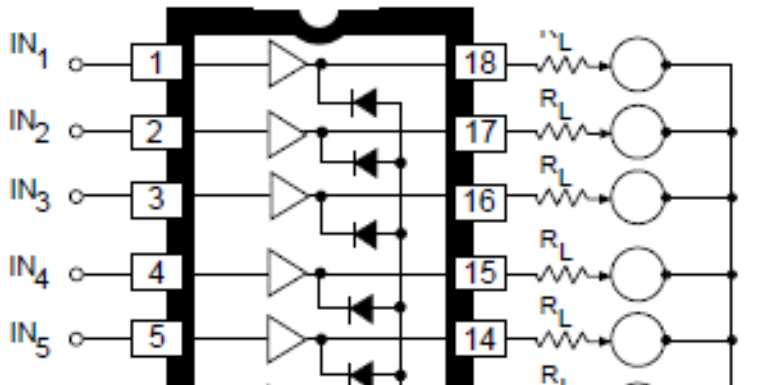
Two separate positive connections



- **UDN2981: 8 Channel Source Driver**

  : the Positive Voltage (Source) (Pin 9) will go out toward Outputs (Pin 11-18) when an input (Pin 8 - 1), which match to each output, is HIGH

- http://www.allegromicro.com/en/Products/Part_Numbers/2981/2981.pdf



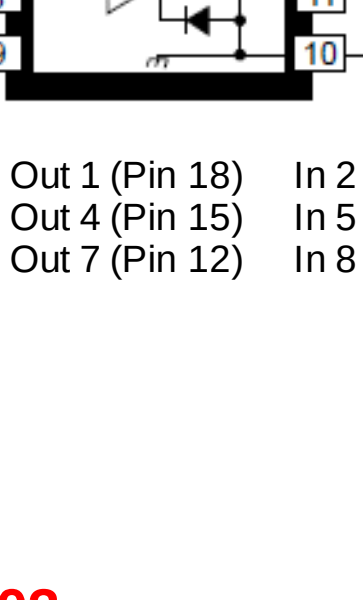
✸ In 1 (Pin 1) ----> Out 1 (Pin 18) In 2 (Pin 2) ----> Out 2 (Pin 17) In 3 (Pin 3) ----> Out 3 (Pin 16)
In 4 (Pin 4) ----> Out 4 (Pin 15) In 5 (Pin 5) ----> Out 5 (Pin 14) In 6 (Pin 6) ----> Out 6 (Pin 13)
In 7 (Pin 7) ----> Out 7 (Pin 12) In 8 (Pin 8) ----> Out 8 (Pin 11)

- **ULN 2803 : Octal High Voltage and Currency Darlington Transistor Array**

  : GND (Pin 9) will be connected toward Outputs (Pin 11-18) when an input (Pin 8 - 1), which match to each output, is HIGH

- data sheet: ftp://www.puc-campinas.edu.br/pub/professores/ceatec/label/Datasheet/ULN2803.pdf

PIN CONNECTIONS



✸ In 1 (Pin 1) ----> Out 1 (Pin 18) In 2 (Pin 2) ----> Out 2 (Pin 17) In 3 (Pin 3) ----> Out 3 (Pin 16)
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In 7 (Pin 7) ----> Out 7 (Pin 12) In 8 (Pin 8) ----> Out 8 (Pin 11)

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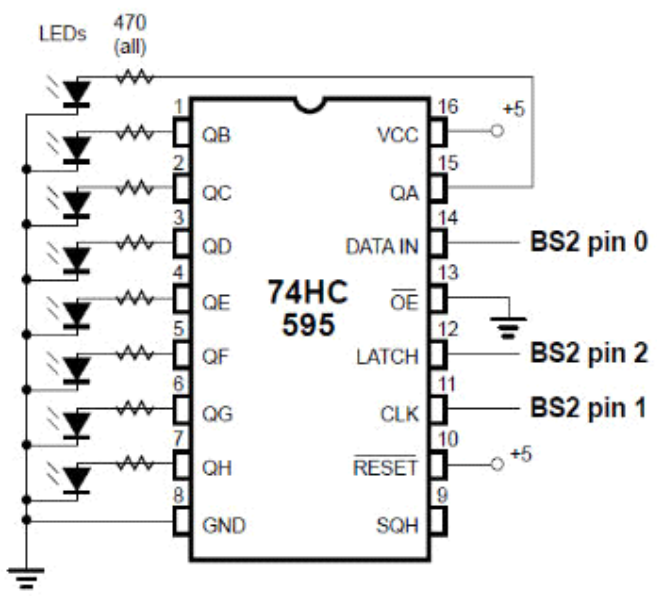
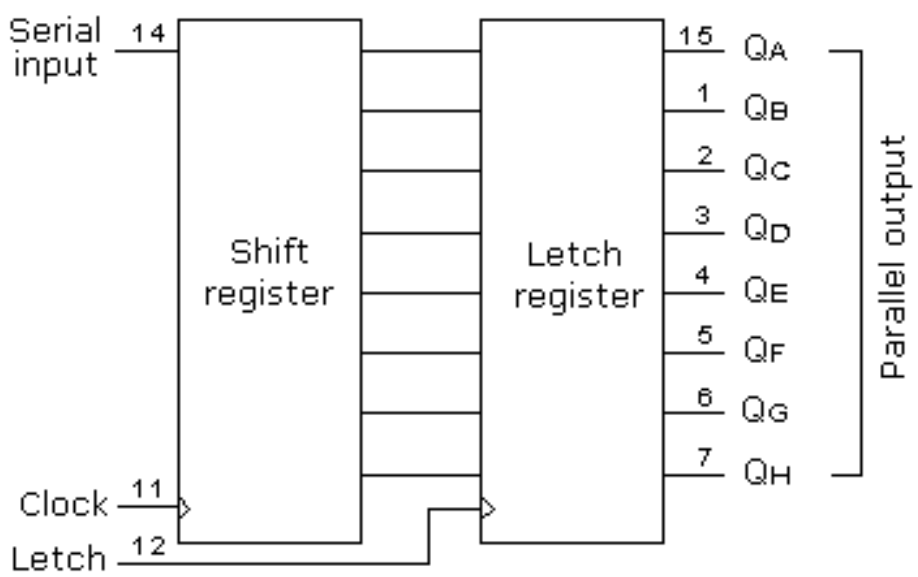
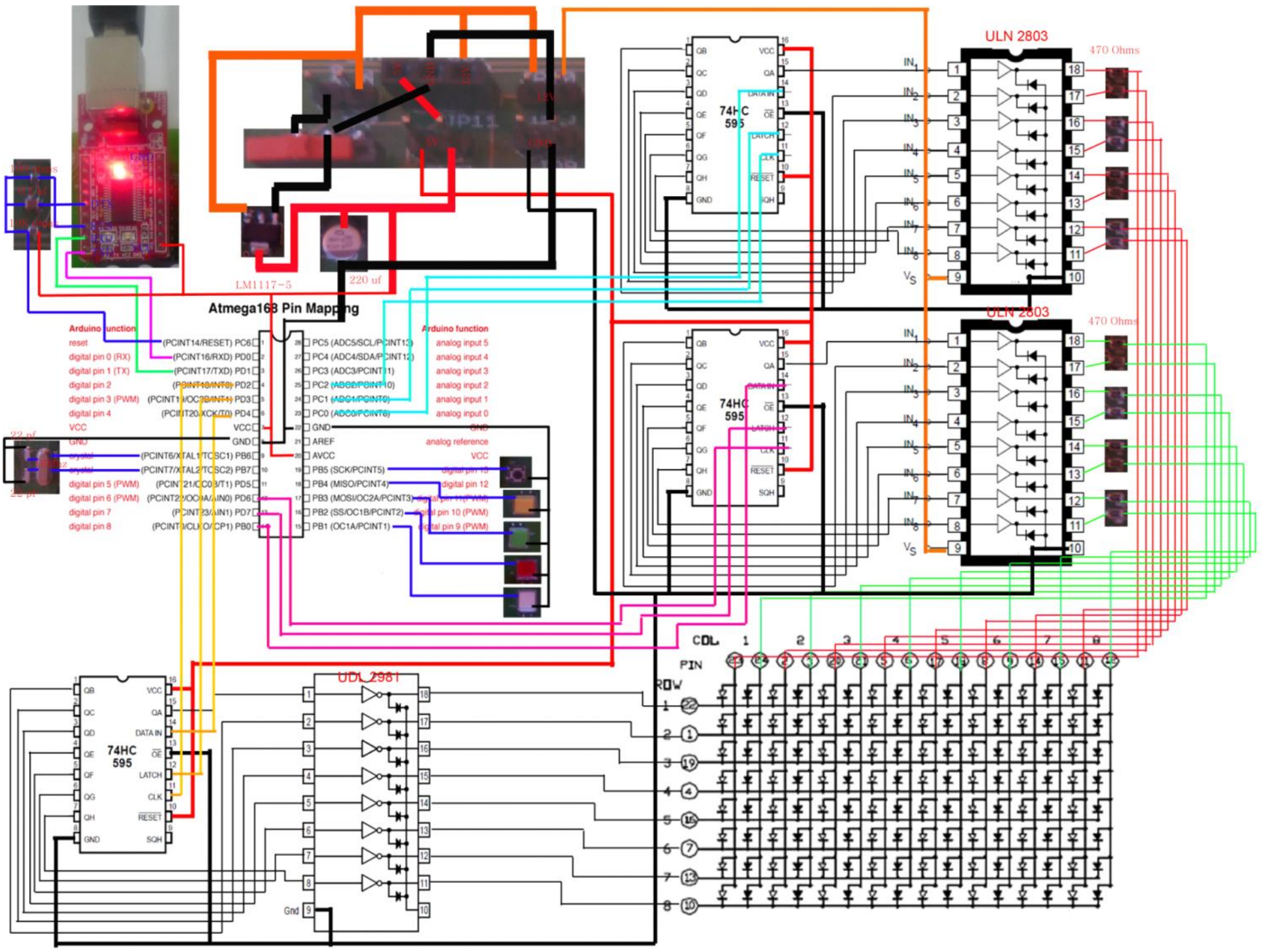
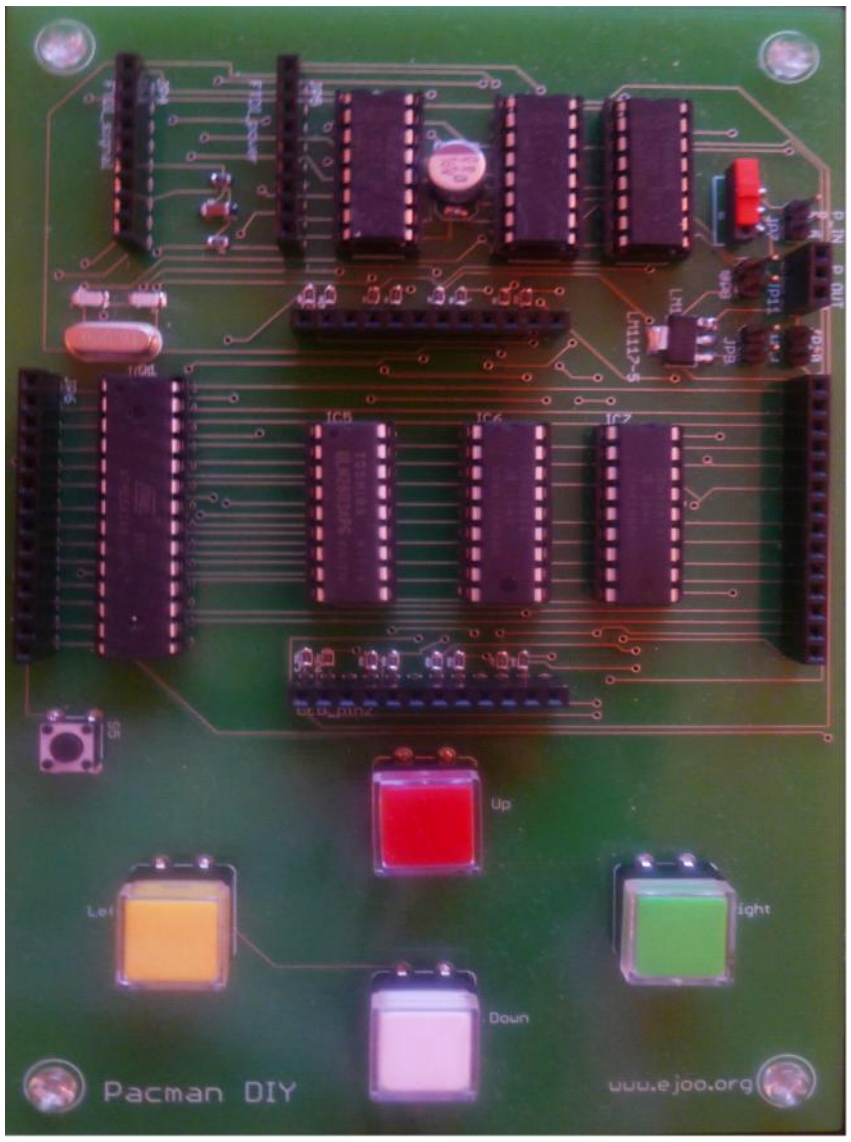
- **74HC595 : 8-bit Serial In ----> 8-bit Serial Out or Parallel Out**
  http://www.nxp.com/documents/data_sheet/74HC_HCT595.pdf

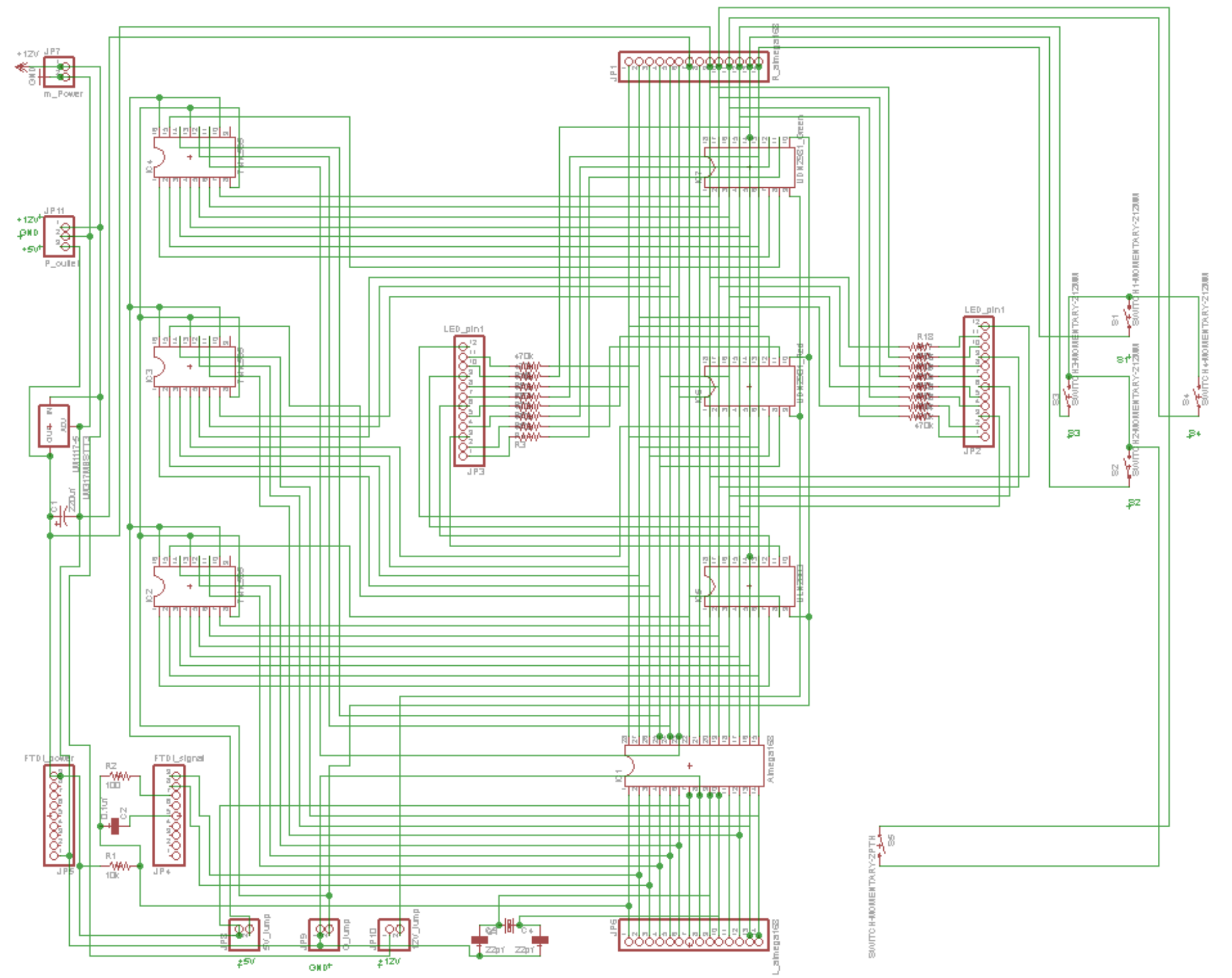






Board_8


Up
Down
Pacman DIY
uuu.ejoo.org


JP7
m_Power
JP11
P_outlet
JP1
R_atmega168
JP2
LED_pin1
JP3
LED_pin1
JP4
FTDI_power
FTDI_signal
JP5
JP6
5V_Jump
JP9
G_Jump
JP10
12V_Jump
JP8
L_atmega168
SWITCH-MOMENTARY-2PTH
S1
S2
S3
S4
S5
Atmega168
+5V
GND
+12V

What's electricity?

- Reference: from ITP, Physical computing blog by Tom Igoe
  http://www.tigoe.net/pcomp/code/circuits/understanding-electricity

1. Understanding Electricity

(1) Electricity: the flow of electrical energy through some conductive material.

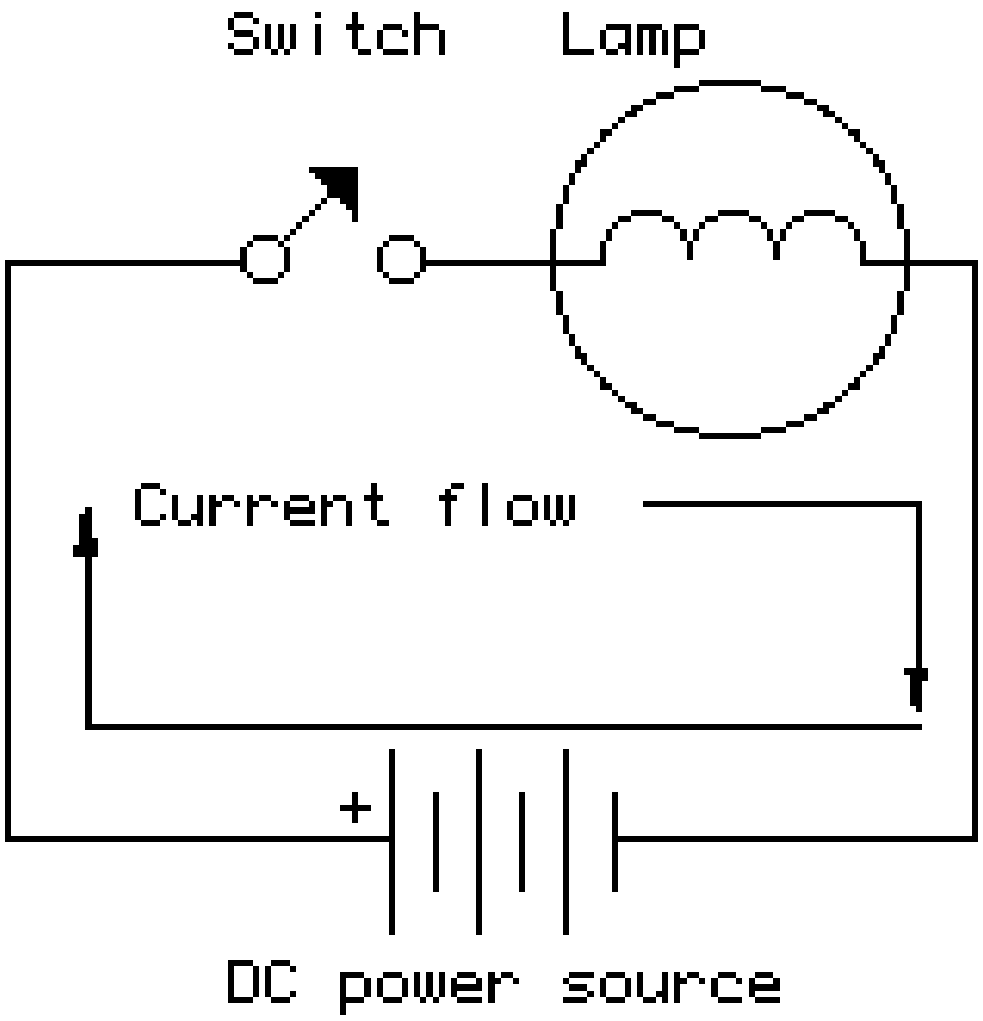
(2) Current: a measure of the magnitude of the flow of electrons in a circuit. (Amperes, or Amps -----> **3A**)
How much water (or electricity) is flowing past a certain point, in the water analogy,
The higher the amperage, the more water (or electricity) is flowing.

(3) Voltage: a measure of the electrical energy of a circuit. (Volts----> **12V**)
Voltage would be the water pressure, in the water analogy,

(4) Resistance: a measure of a material's ability to oppose the flow of electricity. (Ohms ---->Ω)
limiting the current (and the voltage) flowing

(5) A circuit: a closed loop containing a source of electrical energy (like a battery) and a load (like a light bulb).

Every circuit has to have a load of some sort, All of the electrical energy in a circuit has to get used by the load. The load will convert the electrical energy to some other form of energy. A circuit with no load is called a short circuit. In a short circuit, the power source feeds all of its power through the wires and back to itself, and either the wires melt (if you're lucky), or the battery blows up, or something else disastrous happens.
Below is a very basic circuit, consisting of a lamp, a switch, and a battery. The electrical energy coming from the battery is converted to h eat and light energy by the light bulb.



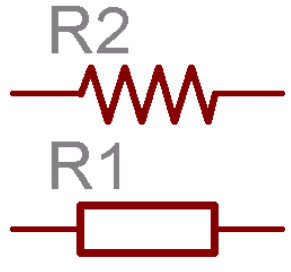
2. Components

(1) Conductors: materials through which electrical current moves freely.

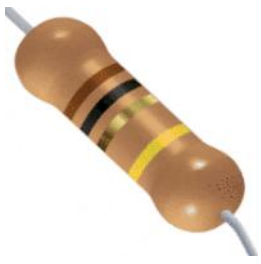
(2) Insulators: materials which prevent the flow of electricity.

(3) Resistors: resist the flow of electricity (currency) but does not totally block it:

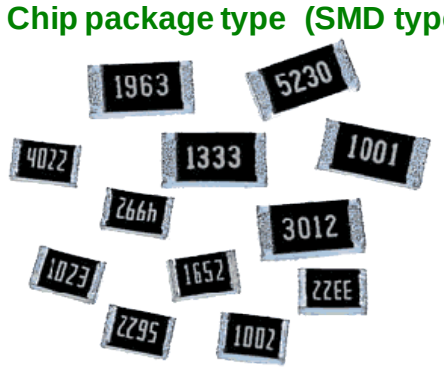
a. To control the flow of current
b. Non-polarized
c. 1000Ω = 1KΩ / 1000KΩ = 1MΩ
d. Online resistor color code converter-----> http://www.ealnet.com/m-eal/resistor/resistor.htm
e. Various package



1. Film type

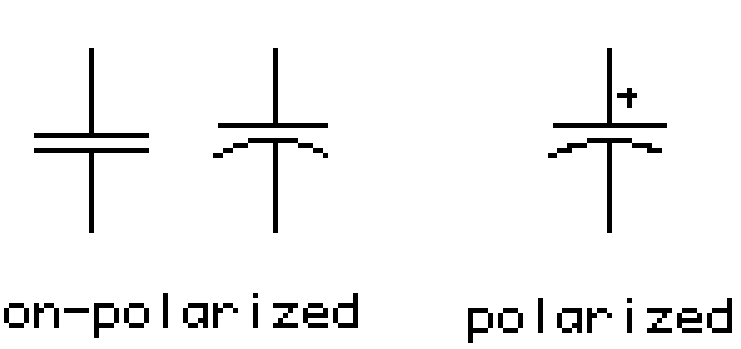


2. Chip package type (SMD type: Surface Mounted Devices)



(4) Capacitors: storing up electricity while current is flowing into them, then release the energy when the incoming current is removed:

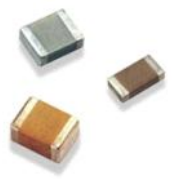
a. Like a chargeable battery
b. Non-polarized / polarized
c. How to calculate the amount of resistance:
   1 uf (micro farad) = 1000 nf(nano farad) 1 nf (nano farad) = 1000 pf(pico farad)
d. Various packages: tantalum, ceramic type packages



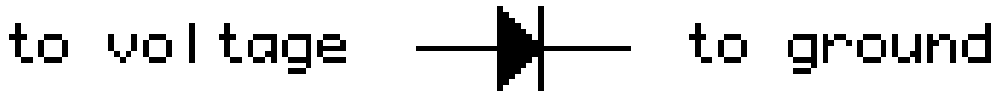
1. Film type

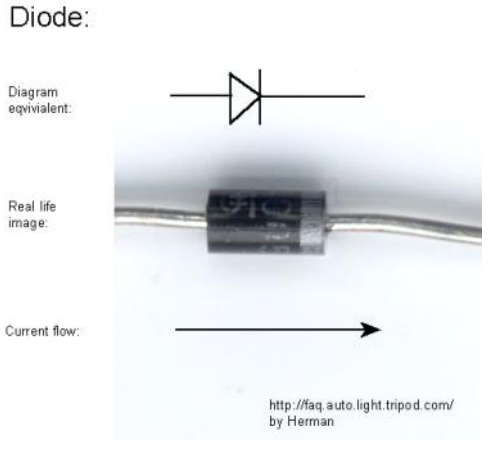
2.Ceramic type

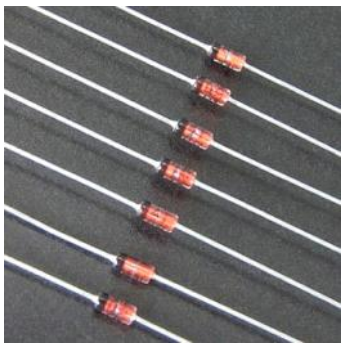
3.Chip type



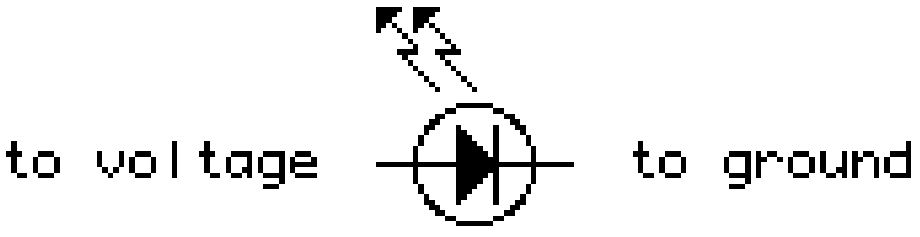
(5) Diode: permitting the flow of electricity in one direction, and block it in the other direction:

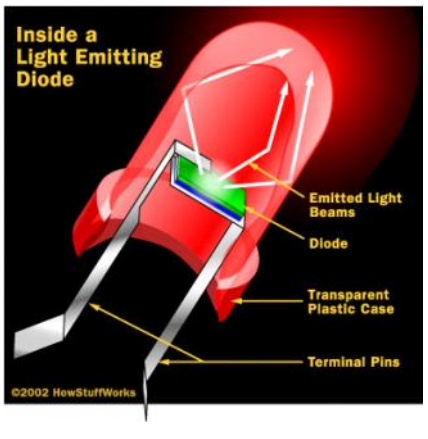


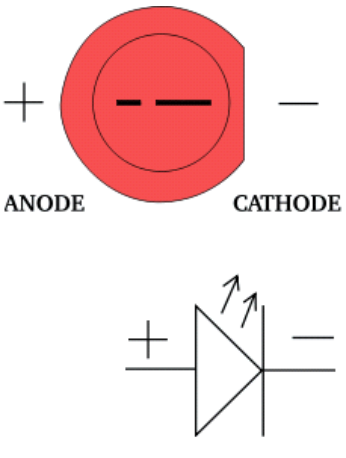


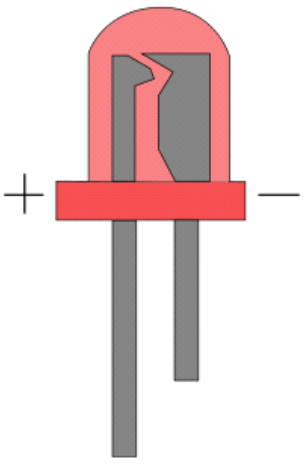


(6) LED(Light-Emitting Diodes): special types of diodes(semiconductor) which emit light when current flows through them
- typically 3.3V 20mA BUT this specefic is always vary depending on led's different color, brightness, sizes and also manufactuing company
- V = IR, R = V / I
- R = 12V / 0.02 (20mA) ---------> R = 600 Ohms



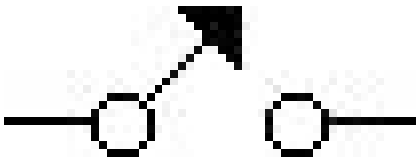


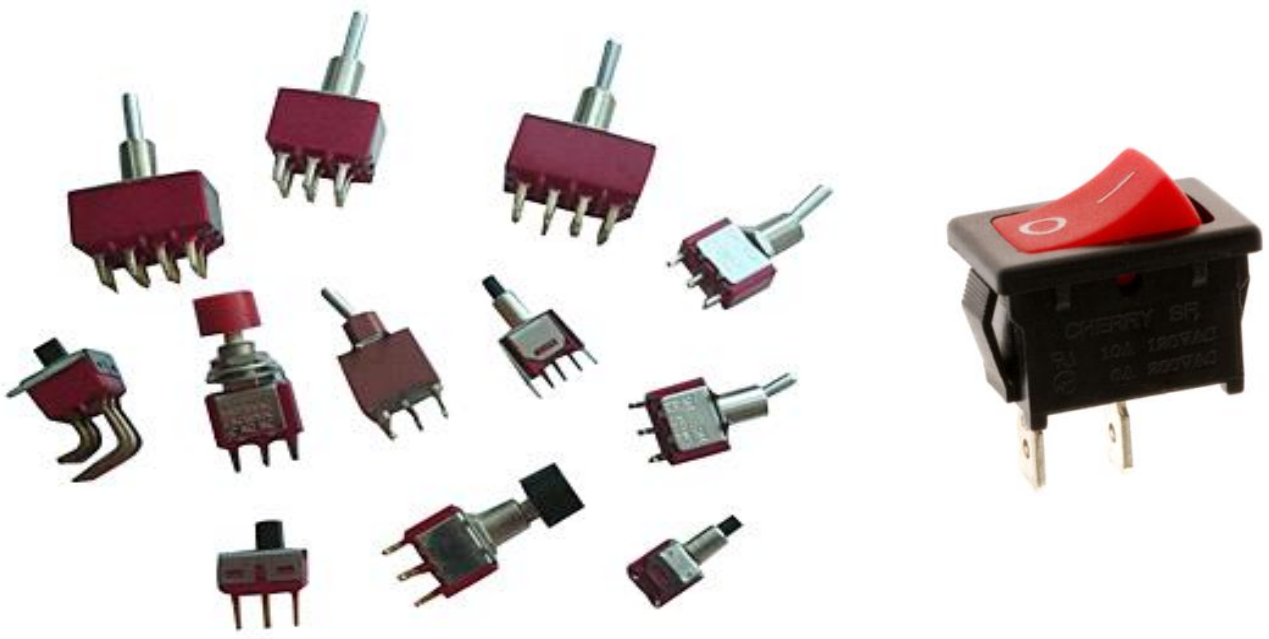




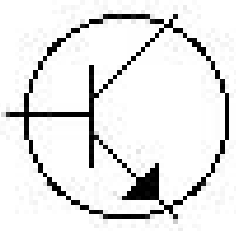
(7) Switches: Controlling the flow of current through a junction in a circuit
Connecting or disconnecting the flow of current by physical controlling (eg. pressing a button by a hand)

a. monetary switch
b. push-button switch
c. toggle switch

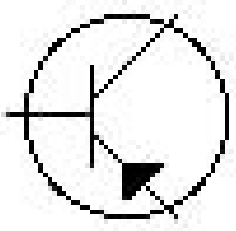




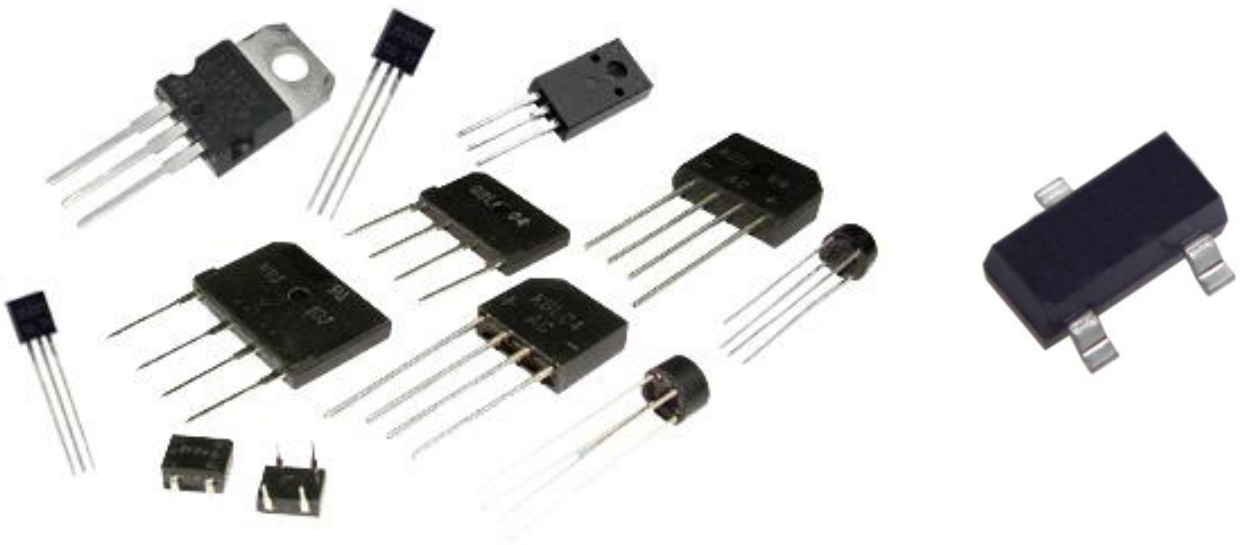
(8) Transistors: Switching devices but digital controlling(Not by hand's pressing)



NPN Transistor



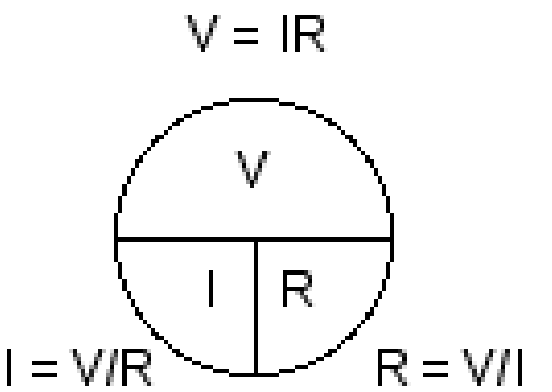
PNP transistor



3. Relationships

- Voltage (V), Current (I), Resistance (R)

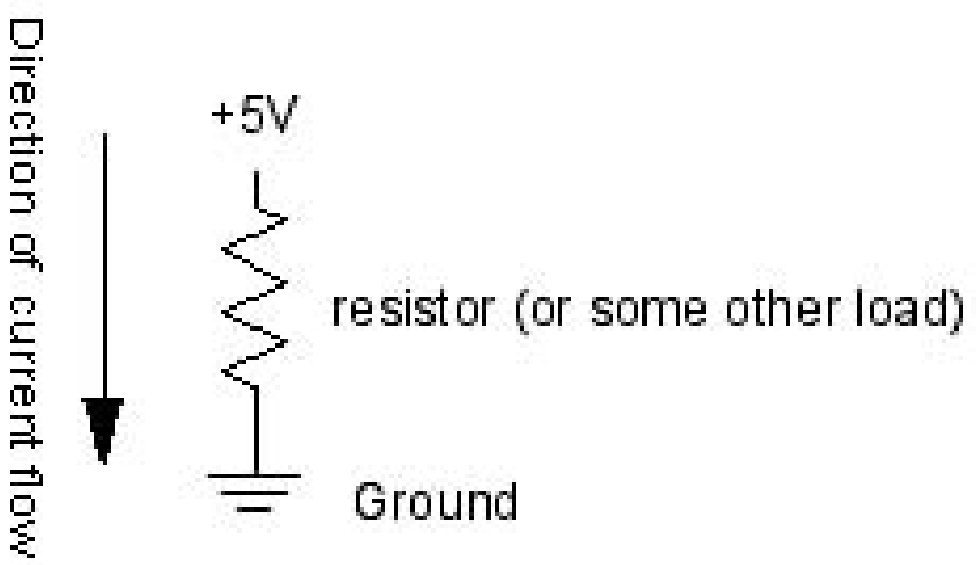
  V = I x R



- Current (I), voltage (V), and resistance (R) are also related to electrical power (P) (measured in watts)(W)

  W = V x A

- Electrical current flows from places of higher potential energy to places of lower potential energy (i.e. from positive to negative).



- **Ground** : the place in a circuit with where the potential energy of the electrons is zero.

- **Current follows the path of least resistance to the ground.**
  So if it has a choice of two paths in a circuit, and one has less resistance, that's the path it'll take.

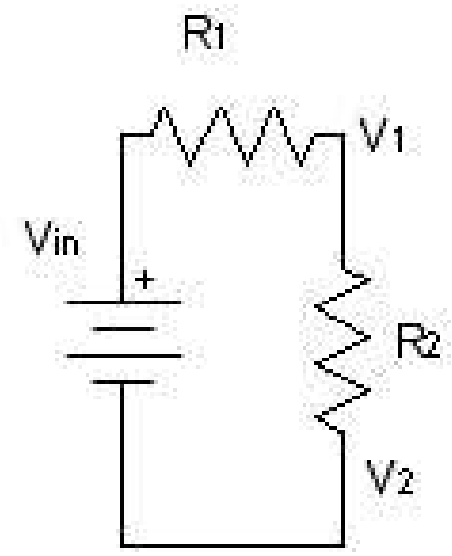
- **In any given circuit, the total voltage around the path of the circuit is zero**.
  Each component that offers a resistance lowers the voltage, and by the time we reach the end of the circuit loop, there will be no voltage left.

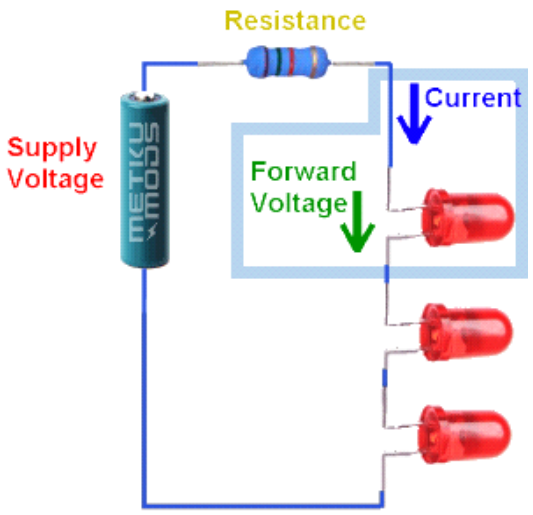
The amount of current going into any point in a circuit is the same as the amount coming out of that point.

These last two rules give us a way to figure out what's going on when we put components in a circuit. When we look at how components in a circuit are placed in relation to each other, there are two ways we can do it:

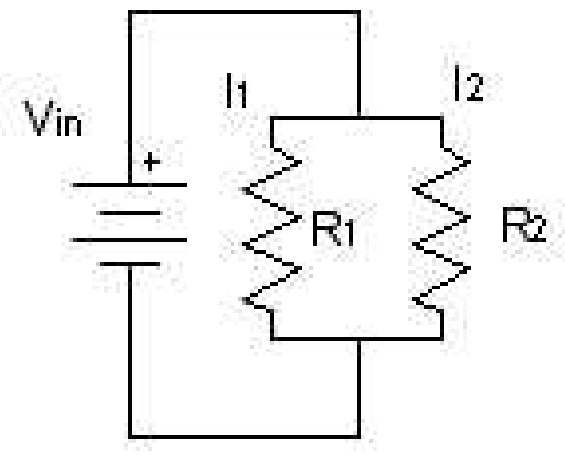
(1) one in line after another, or side by side. When they are one in line after another, we say the components are in **series** with one another

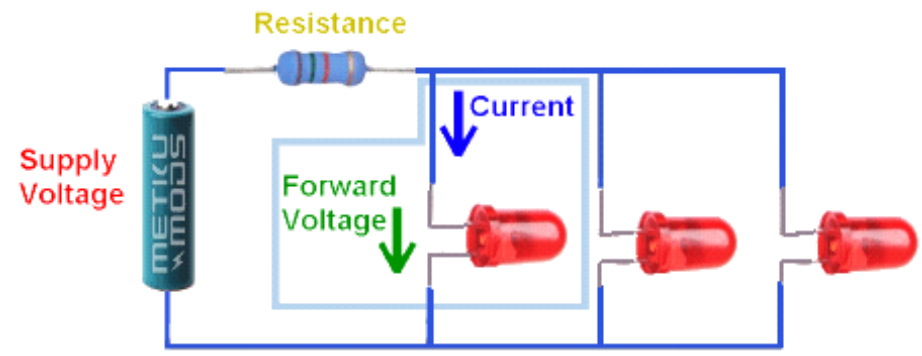
(2) Side by side, they are in **parallel** with one another.





When resistors are in series, the voltage drops across each resistor, and the total resistance is equal to the sum of all the resistors. **Vin = V1 + V2**.





For resistors in parallel, the voltage across them is equal, but the current is divided between them. The total current is constant, however, so we know that the divided current across the parallel resistors is equal to the total current.
I total = I1 + I2

Paraller and serial circuit wiring theory
http://batteryuniversity.com/learn/article/serial_and_parallel_battery_configurations

8X8 LED Matrix datasheet
http://www.devicemart.co.kr/mart7/mall.php?cat=052012002&query=view&no=22550
http://embeddedmicro.com/tutorials/resistors