ECSESS RoboElectronics Club

Breadboards, Power Supplies, and LEDs

Topics Covered

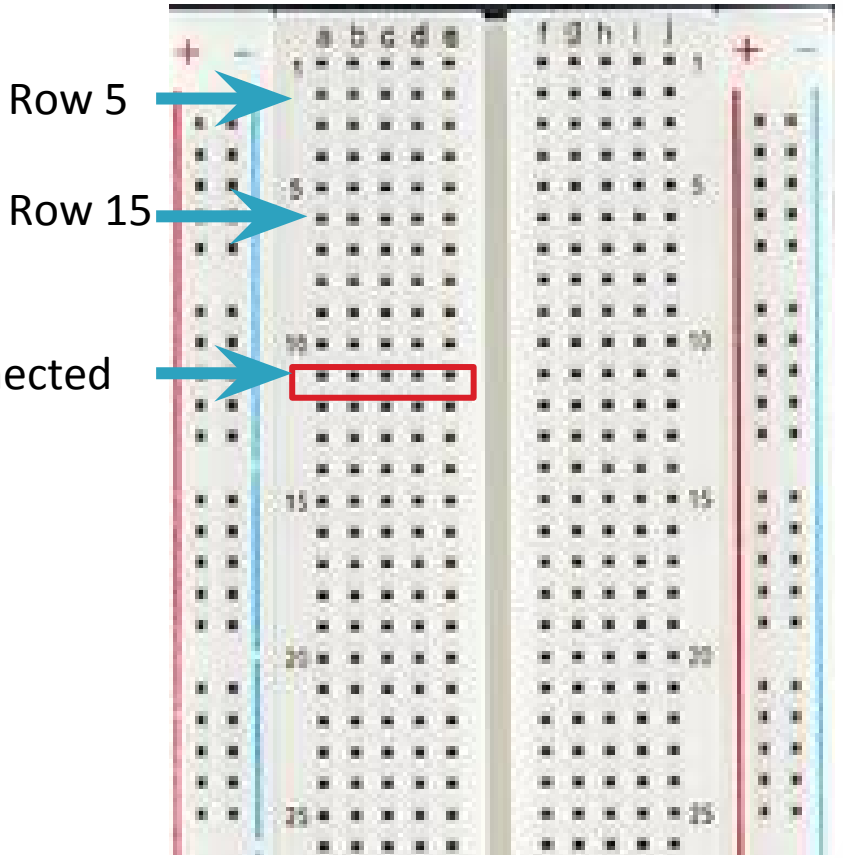
- Basic terminology of digital electronics
- Using breadboards with discrete components
- Fundamentals of DC power supplies and voltage regulators
- Understanding and using LEDs
- Understanding transistors

Terminology

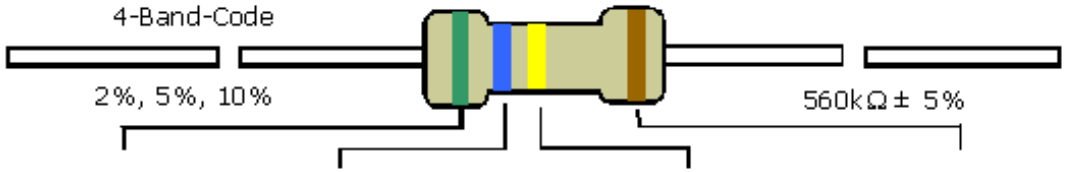
- The following are common terms found in datasheets and digital electronics
  - VDD, VCC, V+: The positive power supply, from a battery or other source. Wire it RED
  - VSS: Ground, GND, or the negative supply. Wire it BLACK
  - HIGH: A value of 1, or VDD placed on an I/O port ,or a signal value
  - LOW: A value of 0, or VSS placed on an I/O port ,or a signal value
  - MCLR: Master clear, or reset pin
  - LED: Light emitting diode
  - DIP: Dual Inline package

Breadboard

- Breadboards allow for quick and easy connection of circuits
- They are made to have discrete components and chips placed on them
- Each row on the board is a continuous piece of copper
- Each row is isolated from the next
  - Row 5 is **not** connected to Row 15
- One line is connected to the other by placing a component, such as a LED or wire, between to rows
- The divider down the middle of the board isolates the left row from the right row



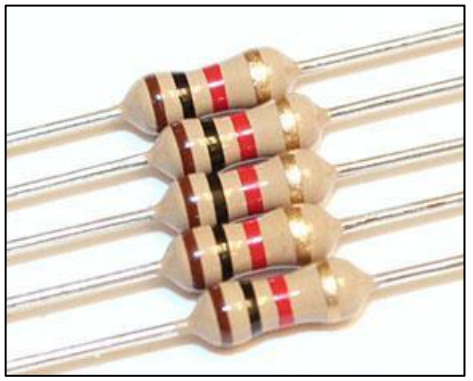
Resistors and Resistor Colour Codes



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE	
Black	0	0	0	1Ω		
Brown	1	1	1	10Ω	± 1%	(F)
Red	2	2	2	100Ω	± 2%	(G)
Orange	3	3	3	1KΩ		
Yellow	4	4	4	10KΩ		
Green	5	5	5	100KΩ	±0.5%	(D)
Blue	6	6	6	1MΩ	±0.25%	(C)
Violet	7	7	7	10MΩ	±0.10%	(B)
Grey	8	8	8		±0.05%	
White	9	9	9			
Gold				0.1	± 5%	(J)
Silver				0.01	± 10%	(K)

Electronix Express / RSR
http://www.elexp.com

1-800-972-2225
In NJ 732-381-8020



4-Band resistor code
These resistors have a value of 10*100 = 1kΩ

Review of Ohms Law

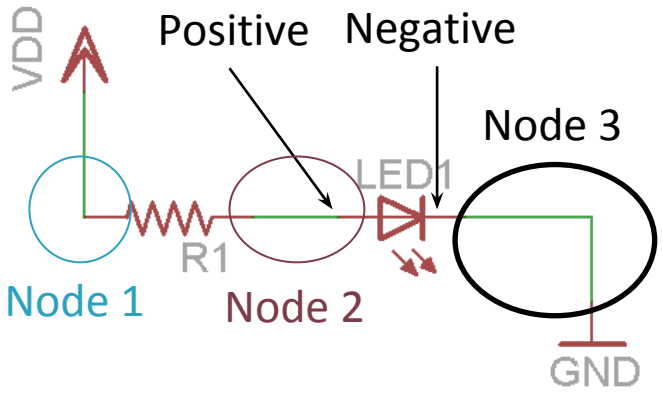
$$\Delta V = I * R$$

$$V_+ - V_i = I_{res} * R$$

Operational Form of Ohm's Law: For a given resistance, there is a voltage drop across that resistance that is proportional to the amount of current flowing through the resistor

From Circuit diagram to breadboard

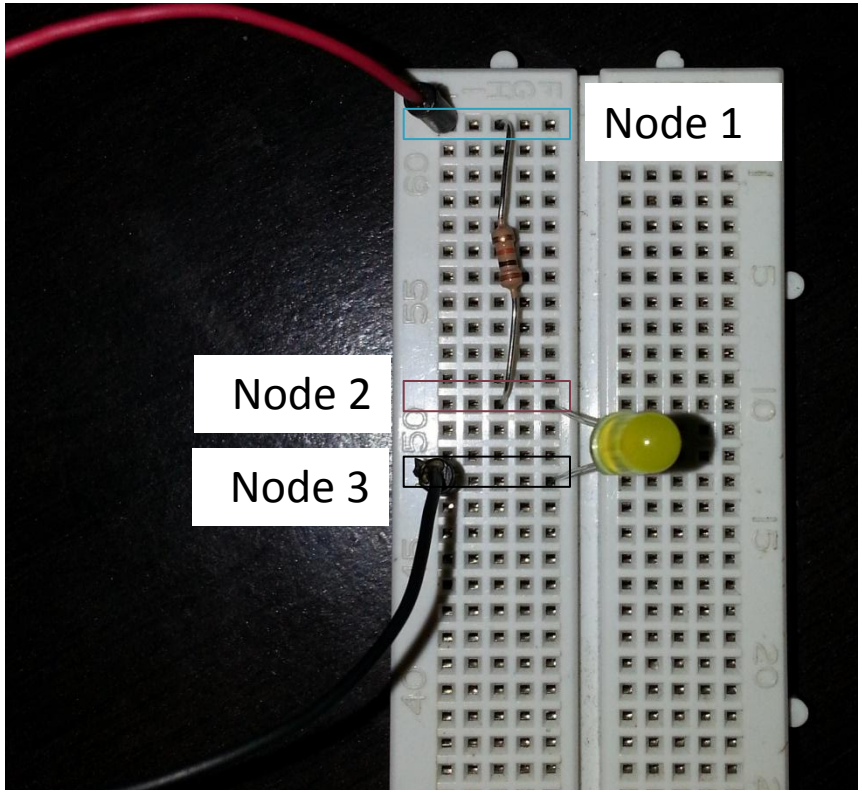
- The following circuit uses a battery to power a LED
  - VDD represents the positive terminal of the battery
  - R1 is a resistor to ensure that the voltage drop across the LED is fixed
  - LED1 is our light, note it has a positive and negative end
  - GND is the negative terminal of the battery
- This simple circuit can be built using a breadboard



A yellow LED, the shorter leg is the negative (-) connection

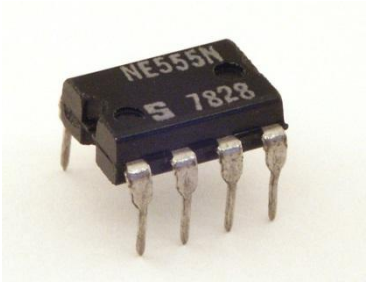
What it looks like on the breadboard

- The following image is the same LED circuit placed on a breadboard
- Each node in the circuit has a corresponding row on the board
- The red wire is the positive supply of the battery connected to the resistor
- The resistor is connected to the positive terminal of the LED
- The LEDs negative terminal is connected to the ground of the battery, which is the black wire

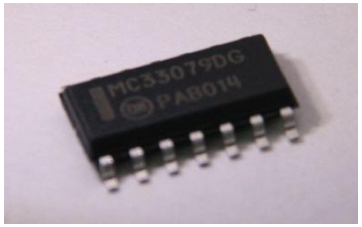


Placing chips on a breadboard

- Chips come in a variety of shapes and sizes referred to as **Packages**
  - Eg. DIP, SOIC, QFP, etc
- As the packages get smaller, you get more pins for the same amount of area
- The largest package, **DIP**, is the only size that will fit directly in a breadboard
- Since these chips have many pins, each of which needs to be isolated from the other, they are placed on the center line of the breadboard



DIP Package (largest)

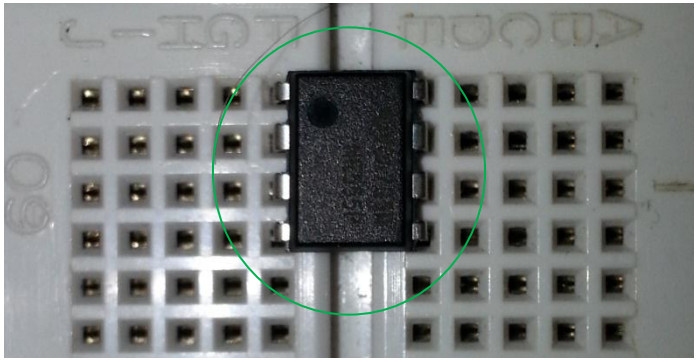


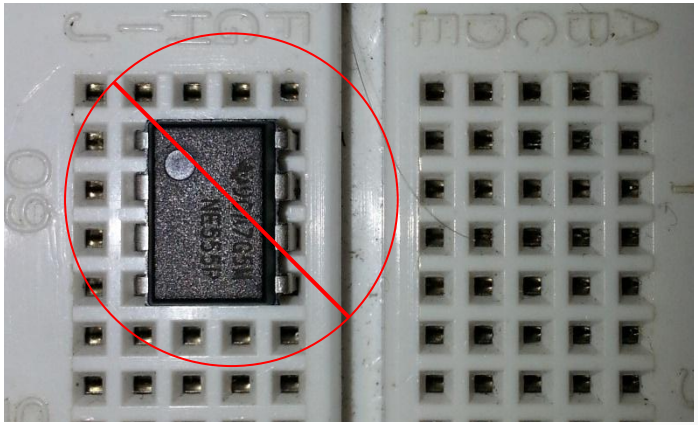
SOIC Package (smaller)

QFP Package (small)

Placing chips on a breadboard

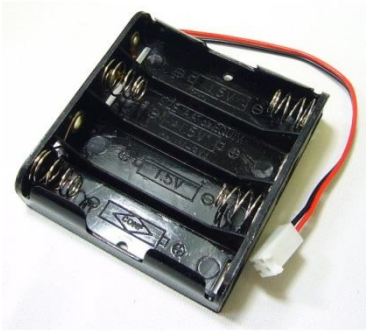
- The following images shows an 8 pin DIP chip inserted into the breadboard
- In the top image the chip is placed along the center line
  - The left side of the board is isolated from the right, which isolates each pin on the chip
- The bottom image shows the chip placed on the left side of the board
  - If the chip is placed entirely on the left or right side of the board pins would be shorted together





DC Power

- All micro electronics run on DC power
- Typical voltages
  - 5V
  - 3.3V
  - 2.0V
- Batteries can be used to supply the necessary voltage, but their voltage varies as a function of time
- DC Transformers that plug into an AC outlet can also be used
- Voltage regulators are used to ensure that devices get specific voltages

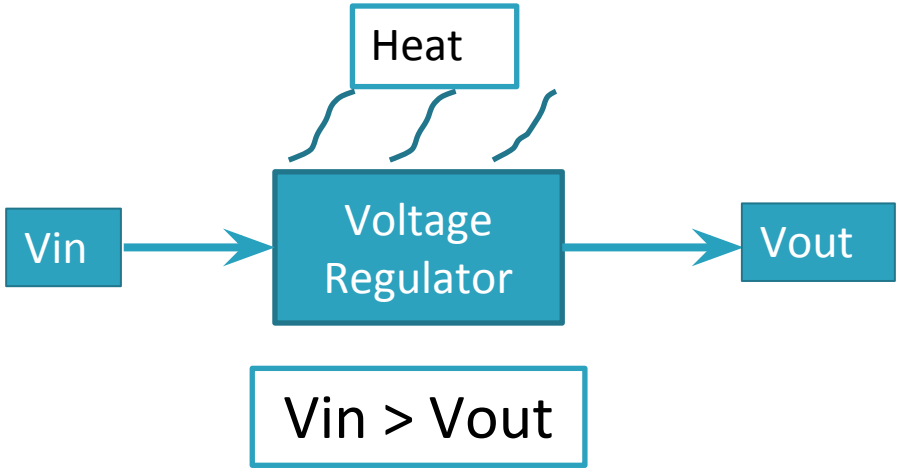


4 AA battery holder giving a total of 6V

A DC transformer that provides a fixed DC voltage from an AC outlet

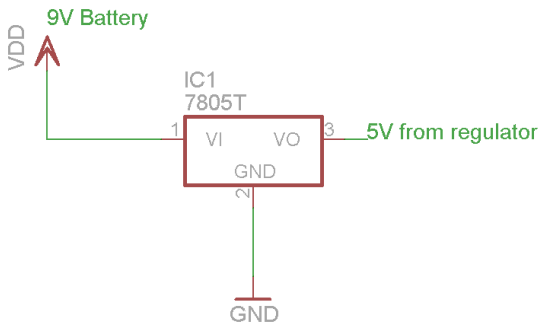
Voltage Regulators

- The voltage of our power supply, such as batteries, could be different from the required voltage of our chips
  - A 3.3V chip cannot sink 6 volts from four AA batteries
  - A 5V chip cannot sink 9 volts from a 9 volt battery
- Instead a **voltage regulator** provides us with a steady fixed voltage to power all our chips

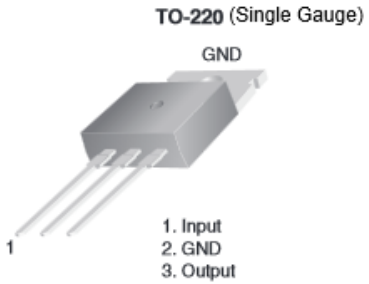


Voltage Regulators

- Voltage regulators are three terminal devices that for any given input voltage give a fixed output voltage
  - This is done by dropping the excess voltage as heat
- A 5 volt regulator when connected to a 9V battery will give exactly 5 volts at its output terminal
- However, they **can not** generate voltage. A 3V battery connected to a 5 volt regulator does not give 5 Volts
- Like chips, they come in a variety of packages and sizes



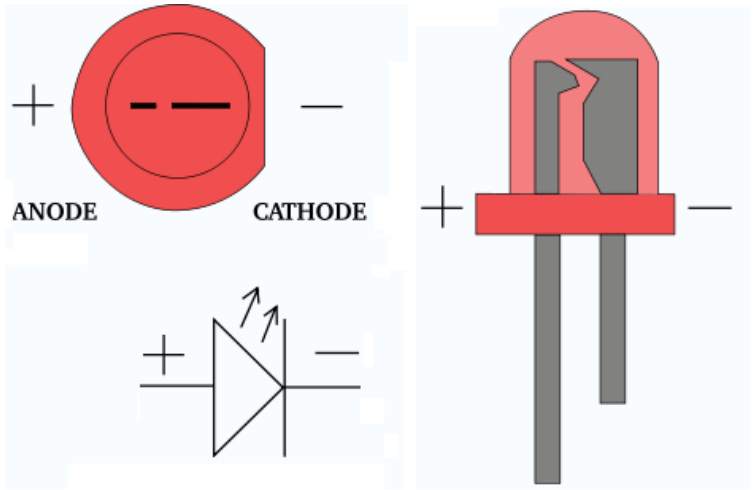
A schematic of an LM7805 regulator connected to a 9V battery



Graphic showing the pin out of an LM7805 5V regulator in TO-220 package

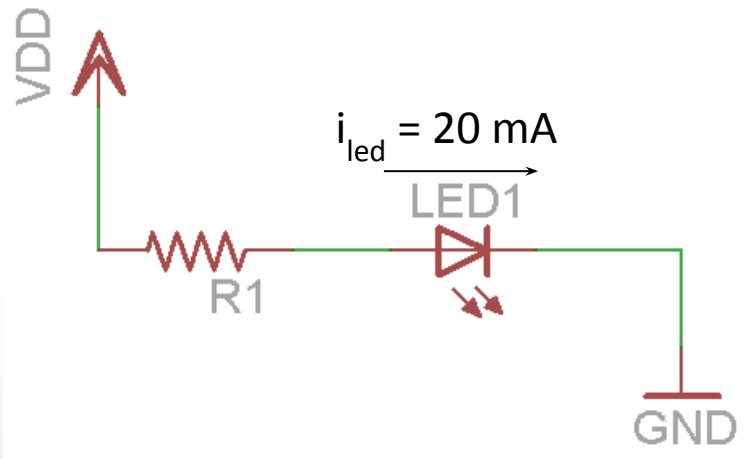
Light Emitting Diodes

- LEDs, Light Emitting Diodes, are a common device found in most electronics
- They are available in a wide variety of sizes and colours
- LEDs have a specific amount of current and voltage that they can handle
  - Resistors are used to ensure that there is a fixed voltage drop across the LED



LEDs

- The yellow LED has a typical forward current of 20 mA and a voltage drop of 2V
- VDD is 5 volts
- Find R1 such that the current through LED1 is 20 mA



$$i_R = i_{LED}$$

$$V_{DD} - V_x = i_R * R_1$$

$$R_1 = \frac{V_{DD} - V_x}{i_{LED}}$$

LEDs

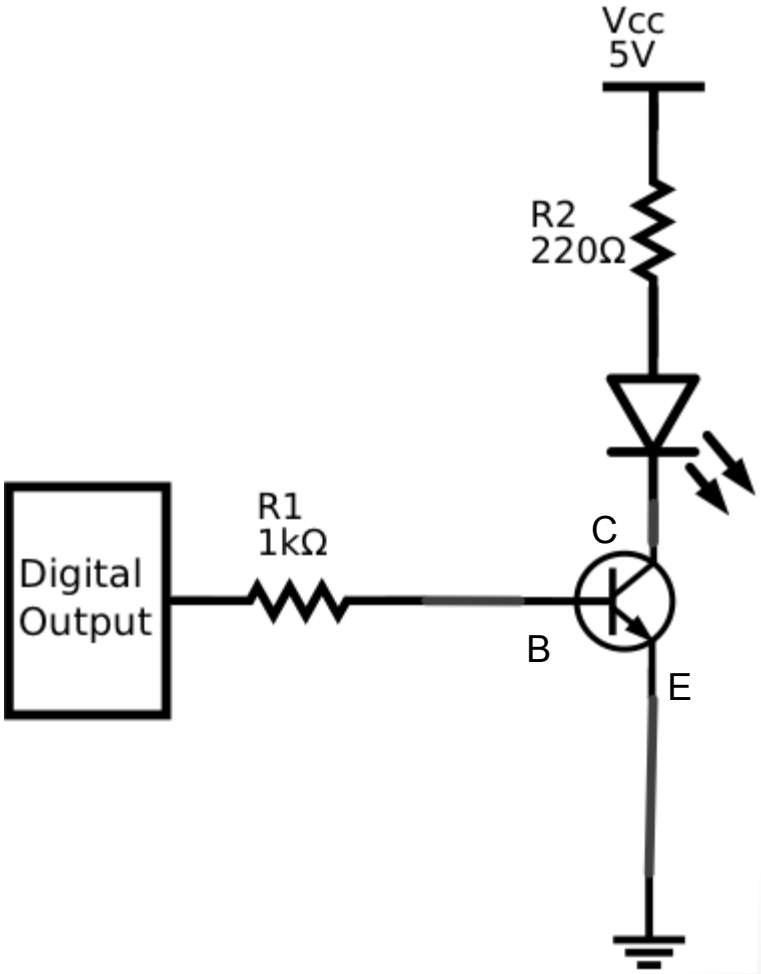
- Depending on the colour, size, and voltage rating, the i_{led} and voltage drop across the LED will change
- Also, the value of your power supply will change the required resistor value for each LED
- Always refer to the datasheet for the rating of the LEDs you are using
- The formulas given on the previous slide will allow you to calculate the correct resistor value
- If a larger resistance is placed before the LED, the brightness will be dimmed

Other LED Colours

1206 smd LEDs 3.2x1.6x1.1MM		Forward voltage		Dominant wavelength		Luminous Intensity		Viewing angle
Part number	Emitting Color	(V) IF=20mA		IF=20mA		(mcd) IF=20mA		
		TYP	MAX	MIN	MAX	TYP	MAX	(degree)
SS-1206R	Red	2.1	2.3	640	650	650	660	120
SS-1206Y	Yellow	2.2	2.8	590	600	550	560	120
SS-1206O	Orange	2.2	2.8	635	645	470	480	130
SS-1206B	Blue	3.2	3.4	465	475	650	660	120
SS-1206G	Plain Green	3.2	3.4	568	573	420	430	120
SS-1206JG	Jade-green	3.2	3.4	530	540	590	600	120
SS-1206W	White	3.2	3.4	X=0.285	Y=0.295	500	800	120
SS-1206P	Pink	3.2	3.4	----	---	300	400	120
SS-1206UV	UV(Purple)	3.2	3.4	380	400	120	160	120

Transistors

- Transistor are the fundamental building blocks of all electronic devices
- They can be used as amplifiers
- **They can be used as digital switches**
- The following diagram shows a common way to control an LED using a NPN BJT transistor as a digital switch
- When the digital output is set to 0, the LED is not connected to ground and is turned off.
- When the digital output is set to 1, the LED is connected to ground and is turned on.
  - The base acts as the switch activation portion
  - The collector and emitter are the parts that are connected together when the switch is activated
- Note, using a PNP transistor would reverse this behavior



Resources

- The RoboElectronics page: www.ecsess.com/rcc
- RoboElectronics Club Facebook group: https://www.facebook.com/groups/380363108717035/
- Data Sheets
  - IC Packages: http://en.wikipedia.org/wiki/List_of_integrated_circuit_packaging_types
  - LM7805 Datasheet: https://www.fairchildsemi.com/datasheets/LM/LM7805.pdf
  - Yellow LED Datasheet: https://www.sparkfun.com/datasheets/Components/LED/COM-09594-YSL-R531Y3D-D2.pdf
- Further Reading
  - Basic Tutorials: https://learn.sparkfun.com/tutorials