

Lab Reference Sheets

This document contains useful information for constructing and testing digital logic circuits, including:

- **Pinouts**
- **Data sheets**
- **Capacitor markings and values available in lab**
- **Standard 5% and 10% Resistor and the resistor color code**
- **SK-10 breadboard and an example circuits wired on the breadboard**
- **Building a 5V power supply using a 9V battery and a 5V regulator**

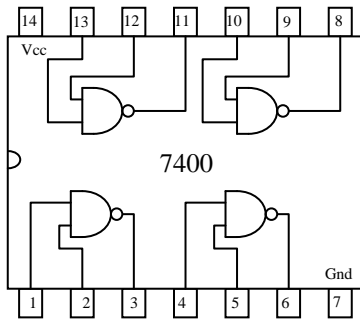
This document is available from the instructor's web page in both Adobe Acrobat format and in Microsoft Word format. If you download the Microsoft Word file, you can copy any of the pinout or other information that you wish into lab reports or other locations.

The Drawing Tools in Microsoft Word were used to create the pinouts and circuits. The Drawing Tools menu usually appears at the bottom of the screen in Word. If it does not, pick **View - Toolbars - Drawing** from the menu. Each pinout has been grouped so that it can be easily moved and resized. To edit a pinout, select the object and then pick **Draw - Ungroup** from the Drawing Tools menu.

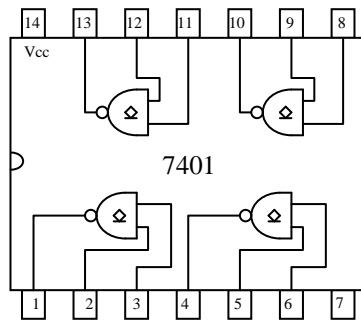
Data Sheets

Data sheets for the devices listed below, along with a number of other devices, are available on the instructor's web page.

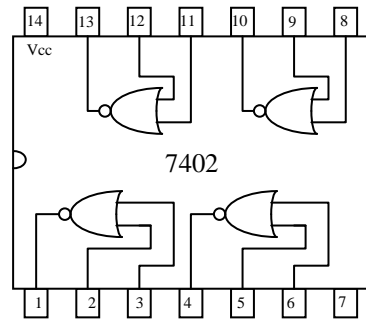
- 7400 – Quad 2-input NAND
- 74HC00 – CMOS Quad 2-input NAND
- 7401 – Open-collector Quad 2-input NAND
- 7406/7416 – Open-collector inverter
- 7447A – BCD-to-7-segment-decoder/driver (for common anode displays)
- 7476– JK flip-flop with Preset and Clear
- 74151 – 8x1 multiplexer (data selector)
- 74155/74156 – Dual 2x4 decoder
- 74191 – Synchronous 4-Bit Up/Down Counter
- 555 – Timer
- GAL22V10 – Programmable Logic Device (PLD)



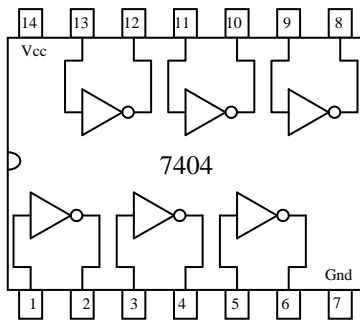
7400 Quad 2-input NAND



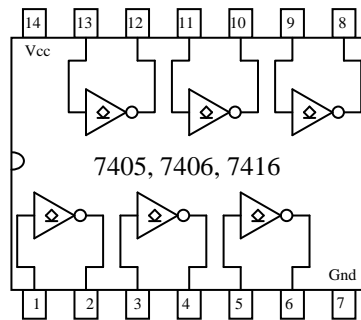
7401 Quad 2-input NAND
(open-collector outputs)



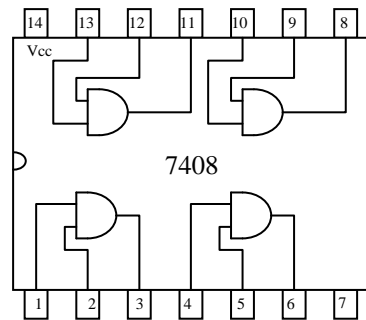
7402 Quad 2-input NOR



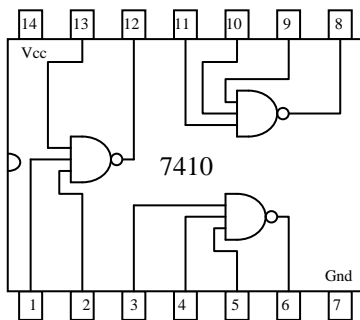
7404 Hex Inverter



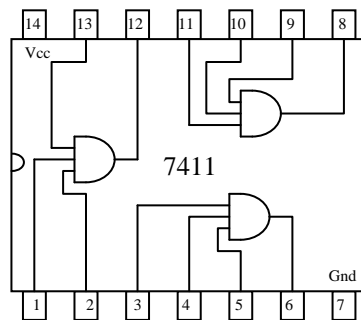
7405, 7406, 7416 Hex Inverter
(open-collector outputs)



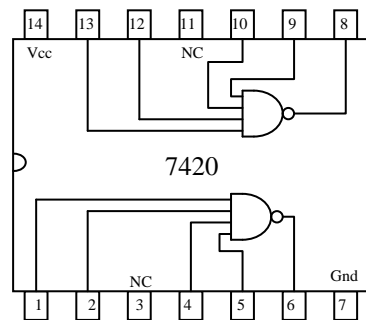
7408 Quad 2-input AND



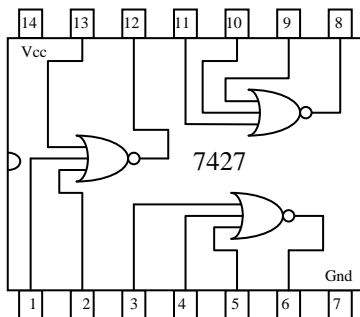
7410 Triple 3-input NAND



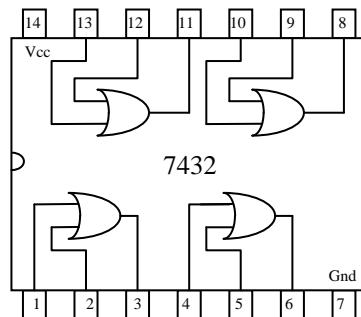
7411 Triple 3-input AND



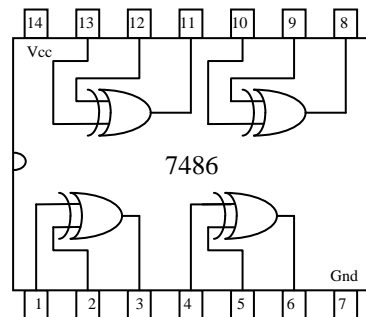
7420 Dual 4-input NAND



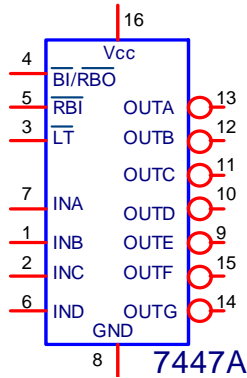
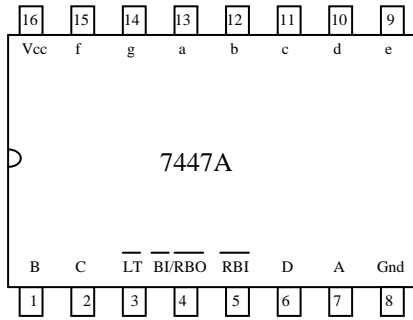
7427 Triple 3-input NOR



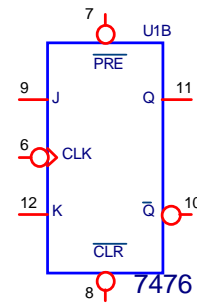
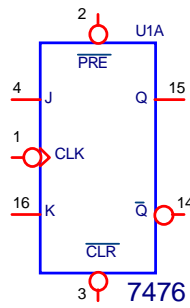
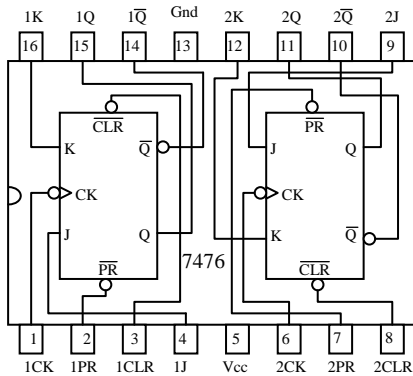
7432 Quad 2-input OR



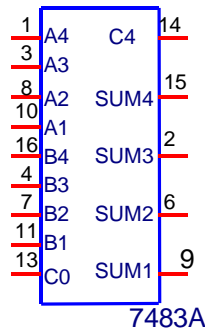
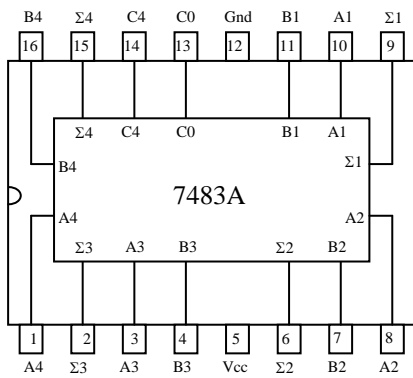
7486 Quad 2-input Exclusive-OR



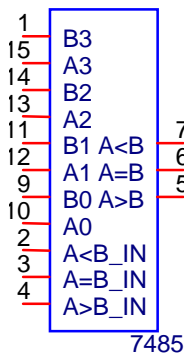
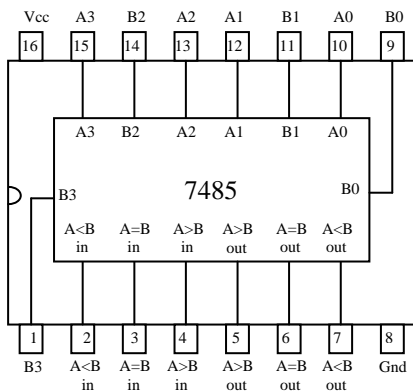
7447A BCD to 7-segment decoder/driver: Pinout and Logic Symbol



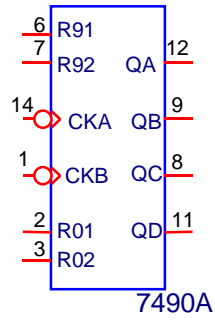
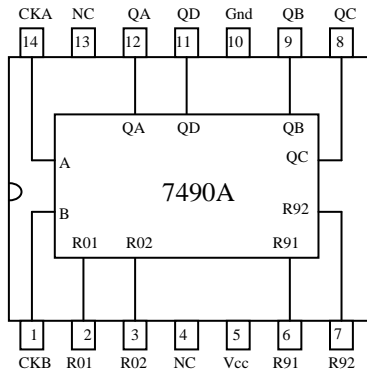
7476 Dual JK Flip-Flop: Pinout and Logic Symbols



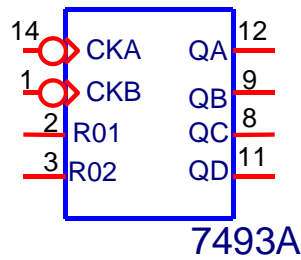
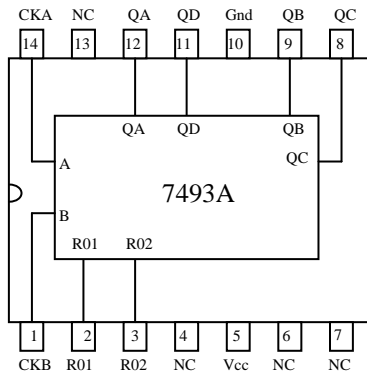
7483A 4-Bit Adder: Pinout and Logic Symbol



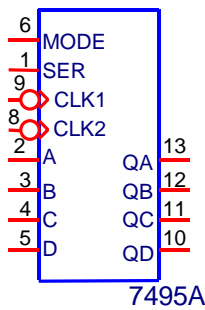
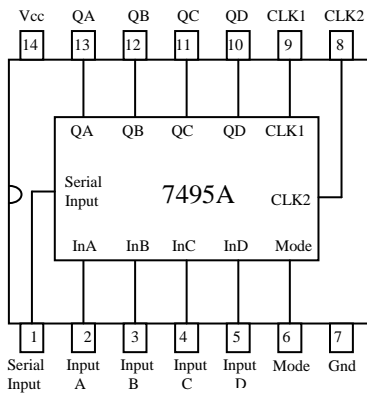
7485 4-Bit Magnitude Comparator: Pinout and Logic Symbol



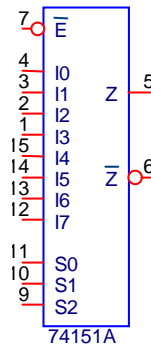
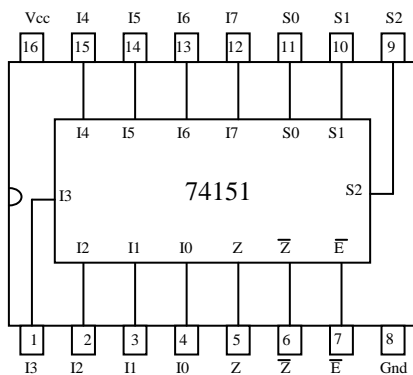
7490A Decade Counter: Pinout and Logic Symbol



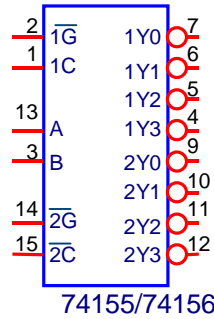
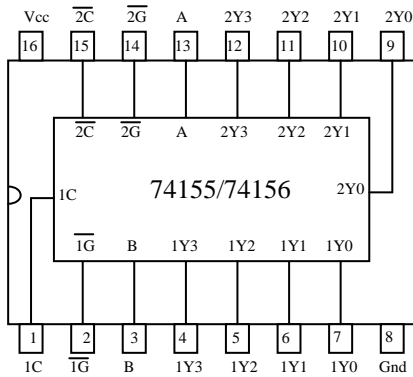
7493A 4-Bit Binary Counter: Pinout and Logic Symbol



7495A 4-Bit Parallel-Load Shift Register: Pinout and Logic Symbol

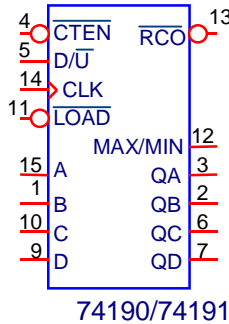
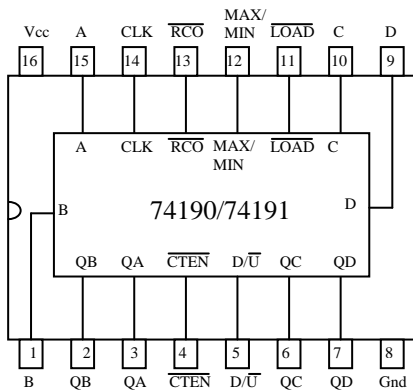


74151 8x1 Data Selector/Multiplexer: Pinout and Logic Symbol



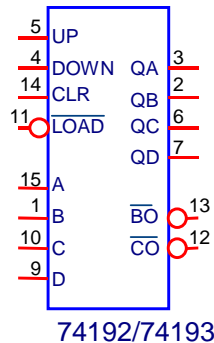
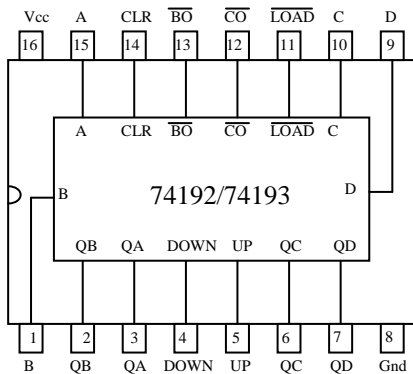
74155 – Totem Pole Outputs
74156 – Open-Collector Outputs

74155/74156 Dual 2-Line To 4-Line Decoder/Demultiplexer: Pinout and Logic Symbol



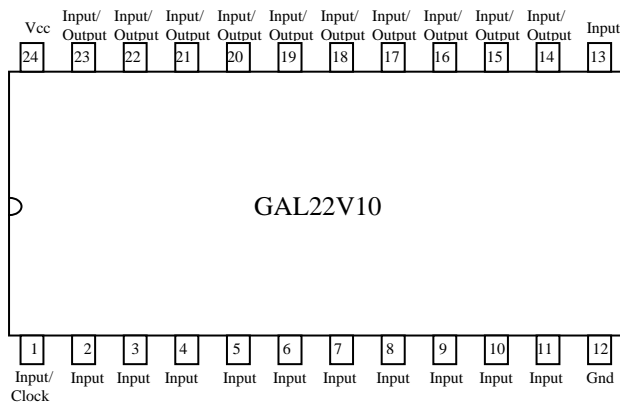
74190 – BCD Counter
74191 – 4-Bit Binary Counter

74190/74191 Synchronous Up/Down Counter: Pinout and Logic Symbol

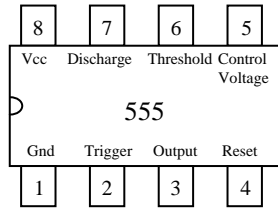
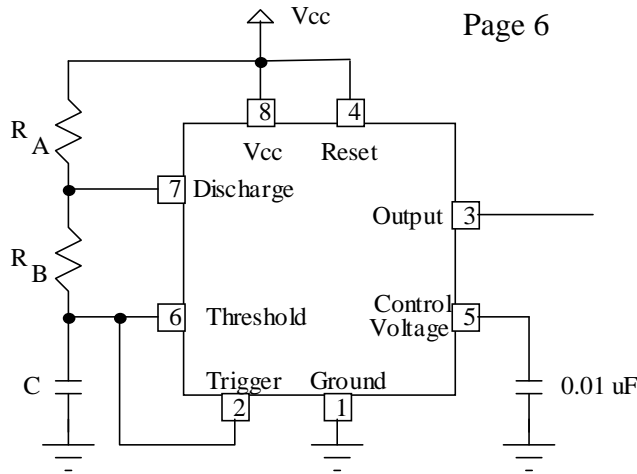


74192 – BCD Counter
74193 – 4-Bit Binary Counter

74192/74193 Synchronous Up/Down Counter: Pinout and Logic Symbol



GAL22V10 PLD (Programmable Logic Device)



Example: If $C = 0.1 \mu\text{F}$, $R_A = 5 \text{ k}\Omega$, and $R_B = 4.4 \text{ k}\Omega$, then $T_H = 651.4 \mu\text{s}$, $T_L = 304.9 \mu\text{s}$, $T = 956.3 \mu\text{s}$, $f = 1046 \text{ Hz}$, and $D = 68.1 \%$

555 Timer connected as an astable multivibrator (clock generator)

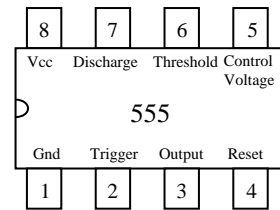
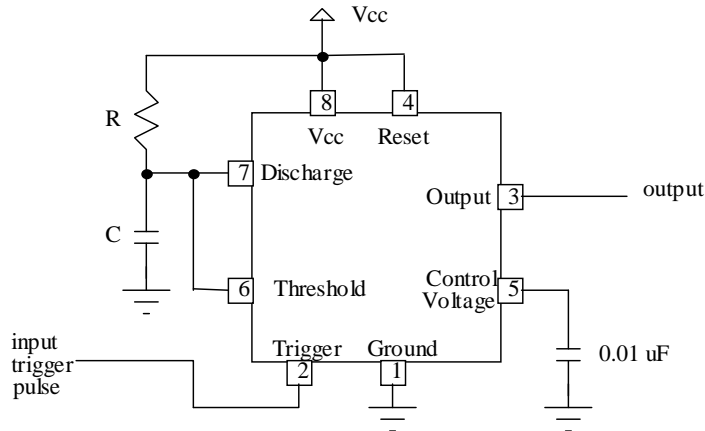
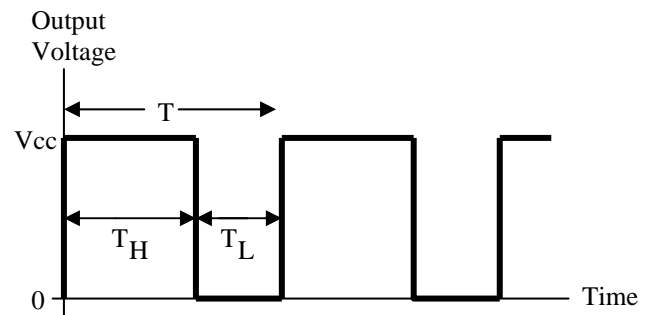
$$T_H = 0.693(R_A + R_B)C$$

$$T_L = 0.693(R_B)C$$

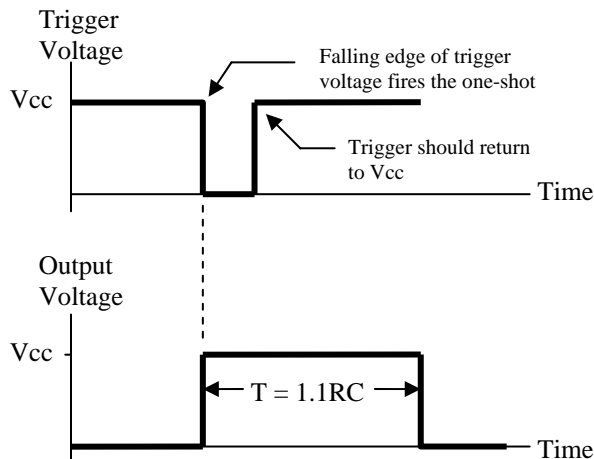
$$T = T_H + T_L = 0.693(R_A + 2R_B)C$$

$$f = \frac{1}{T} = \frac{1.44}{(R_A + 2R_B)C}$$

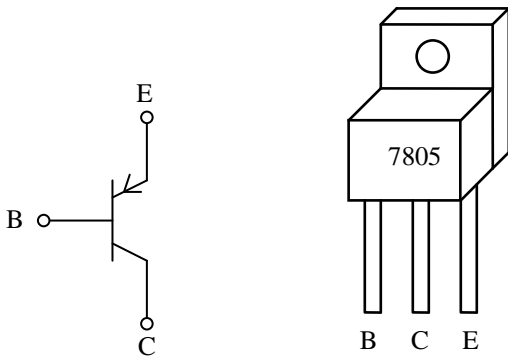
$$D = \text{Duty Cycle} = \frac{T_H}{T} = \frac{R_A + R_B}{R_A + 2R_B} \times 100\%$$



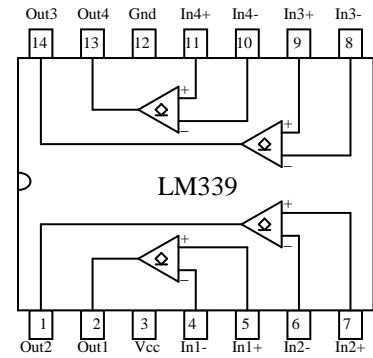
555 Timer connected as a monostable multivibrator (one-shot)



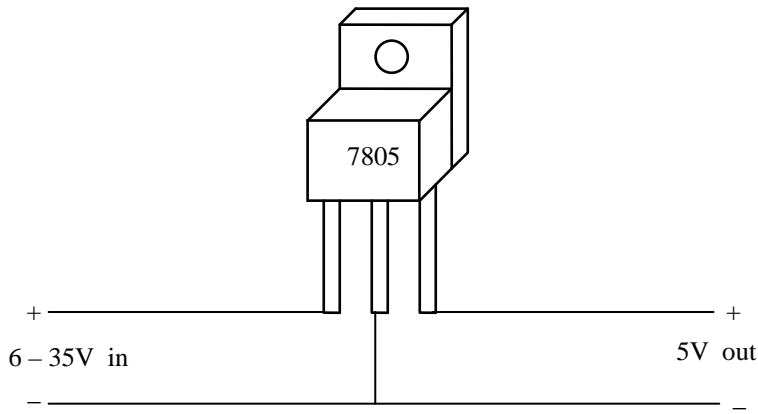
Example: If $C = 0.1 \mu\text{F}$ and $R = 47 \text{ k}\Omega$, then $T = 1.1(47 \text{ k}\Omega)(0.1 \mu\text{F}) = 5.17 \text{ ms}$. So, each time the one-shot is triggered, an output pulse with a duration of 5.17 ms is produced.



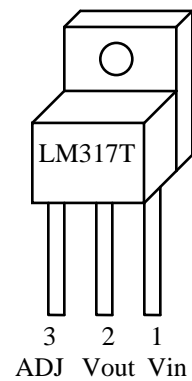
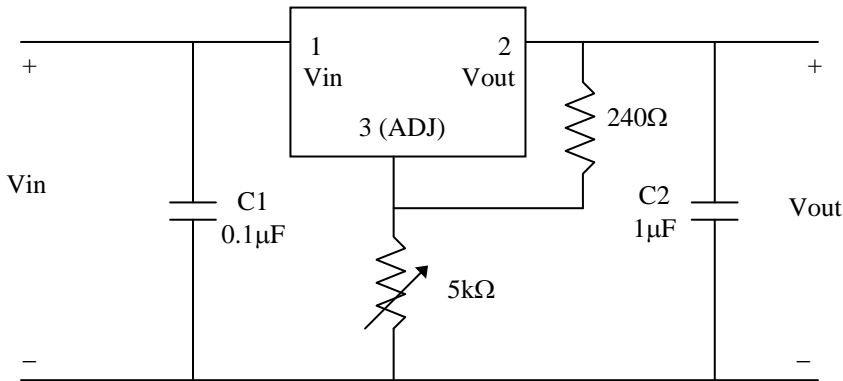
TIP30 PNP Transistor Symbol and Pin Assignment



LM339 Quad Comparator
(open-collector outputs)



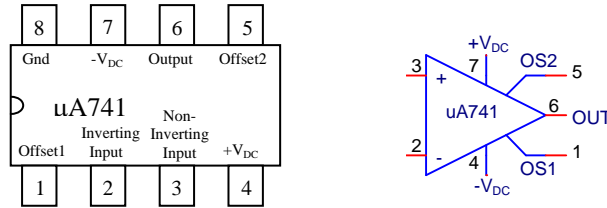
7805 5V Regulator



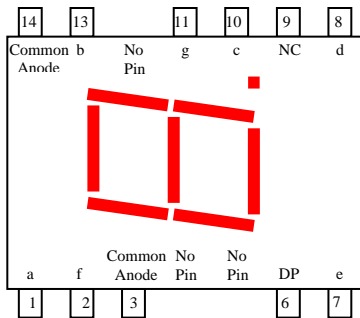
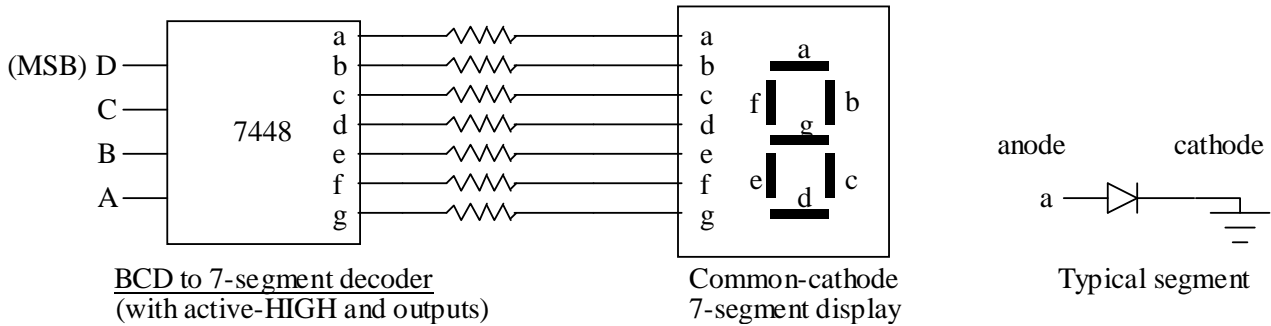
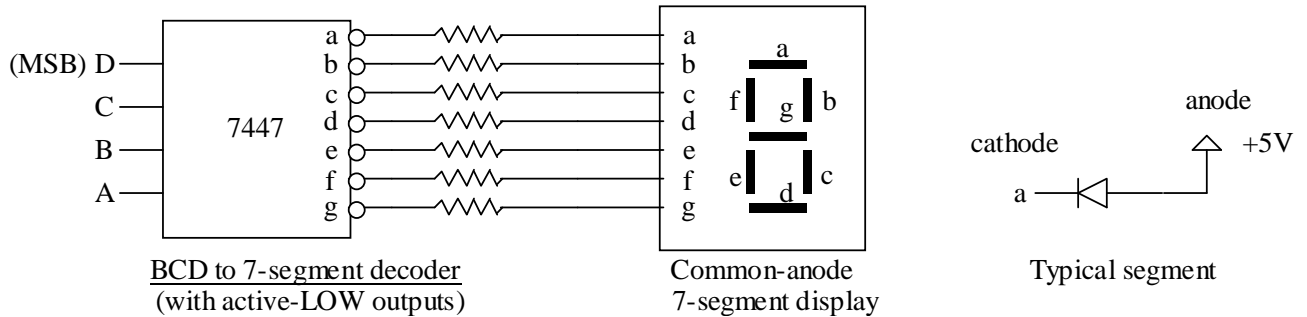
LM317T Adjustable Regulator

Notes:

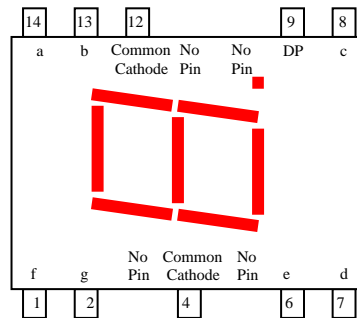
- 1) C1 is optional – improves transient response
- 2) C2 is needed only if device is far from filter capacitors
- 3) Vout adjustable +1.2V to +37V
- 4) Vout is tied to the heat sink



uA741 Operational Amplifier: Pinout and Symbol



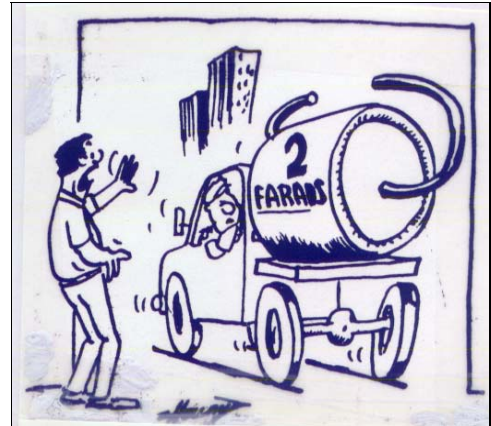
MAN72A Common Anode 7-segment Display
(common anode connection to Vcc)



MAN74A Common Cathode 7-segment Display
(common cathode connection to ground)

Capacitor values available in the EGR 270 lab
(all values are in μF)

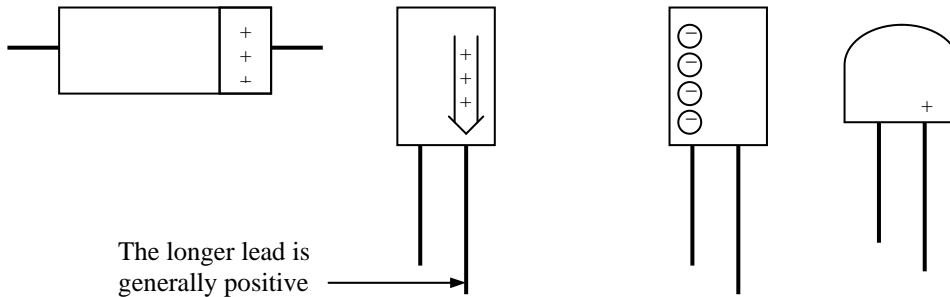
.001	.01	.1	1	10	100	1000
	.015	.15		12, 15	120	1500
.0022	.022	.22	2.2	22	200, 220	
	.027	.27	3	25		
.0033	.033	.33	3.3	33		
.0047	.047	.47	4.7	47	470	
		.56	5	50	500	
.0068	.068	.68	6.8			
	.082	.82				



"Hold it! I said 2 **MICRO** farads!"

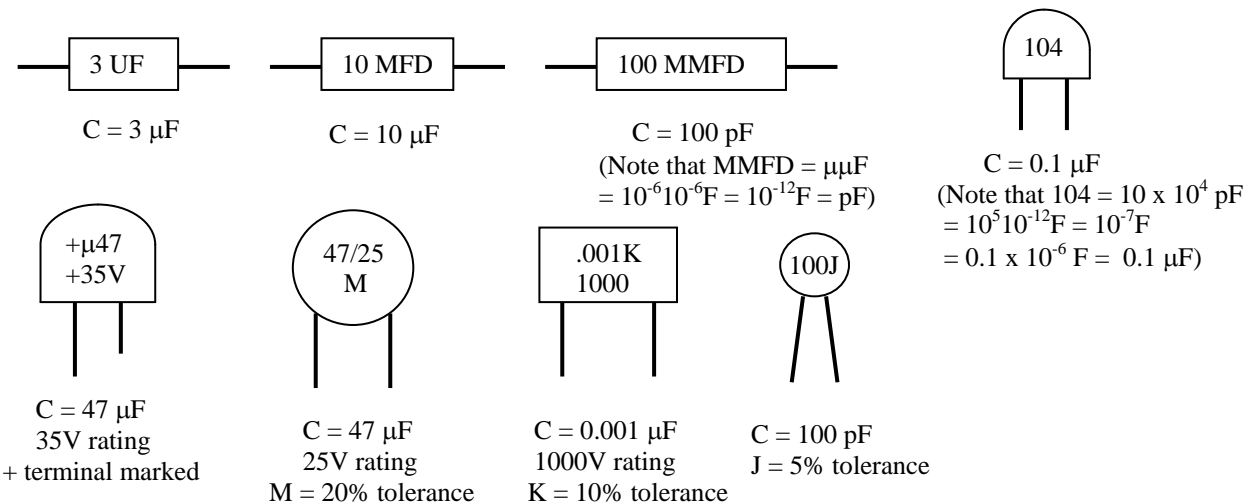
Polarized capacitors:

Polarity is important on some capacitors. Most capacitors that look like metal cans are *electrolytic capacitors* and are polarized. If a capacitor is polarized it should have a terminal marked as being positive (+) or negative (-). Be sure to connect it with the proper polarity. Connecting a polarized capacitor with reverse polarity can sometimes yield errors and in extreme cases the capacitors can explode! Some common markings for polarized capacitors are shown below.



Capacitors values:

Capacitors vary tremendously in size, color, shape, and material. The markings on capacitors also vary considerably and they can often be difficult to interpret since various styles are used to specify the value of capacitance. It is a good idea to check capacitor values in lab using an *impedance bridge* if one is available. Several examples of labels found on capacitors are shown below.



Standard values of commercially available resistors

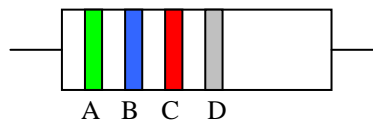
Ohms (Ω)					Kilohms (kΩ)		Megohms (MΩ)	
0.10	1.0	10	100	1000	10	100	1.0	10.0
0.11	1.1	11	110	1100	11	110	1.1	11.0
0.12	1.2	12	120	1200	12	120	1.2	12.0
0.13	1.3	13	130	1300	13	130	1.3	13.0
0.15	1.5	15	150	1500	15	150	1.5	15.0
0.16	1.6	16	160	1600	16	160	1.6	16.0
0.18	1.8	18	180	1800	18	180	1.8	18.0
0.20	2.0	20	200	2000	20	200	2.0	20.0
0.22	2.2	22	220	2200	22	220	2.2	22.0
0.24	2.4	24	240	2400	24	240	2.4	
0.27	2.7	27	270	2700	27	270	2.7	
0.30	3.0	30	300	3000	30	300	3.0	
0.33	3.3	33	330	3300	33	330	3.3	
0.36	3.6	36	360	3600	36	360	3.6	
0.39	3.9	39	390	3900	39	390	3.9	
0.43	4.3	43	430	4300	43	430	4.3	
0.47	4.7	47	470	4700	47	470	4.7	
0.51	5.1	51	510	5100	51	510	5.1	
0.56	5.6	56	560	5600	56	560	5.6	
0.62	6.2	62	620	6200	62	620	6.2	
0.68	6.8	68	680	6800	68	680	6.8	
0.75	7.5	75	750	7500	75	750	7.5	
0.82	8.2	82	820	8200	82	820	8.2	
0.91	9.1	91	910	9100	91	910	9.1	

Notes: All values are available with 5% tolerance.
Only the **bold** values are available with 10% tolerance.

Resistor Color Code

Carbon resistors are typically color-coded using four colored bands labeled A, B, C, and D as indicated below.

Bands A, B, C		Band D	
Black	0	Gold	5%
Brown	1	Silver	10%
Red	2	No band	20%
Orange	3		
Yellow	4		
Green	5		
Blue	6		
Violet	7		
Gray	8		
White	9		
Gold	-1		
Silver	-2		

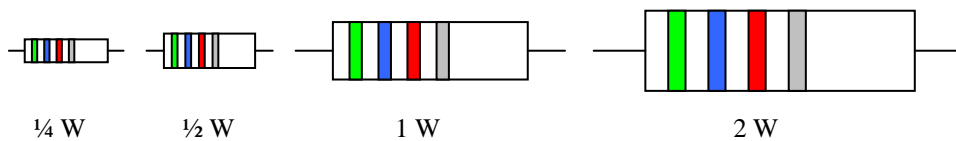


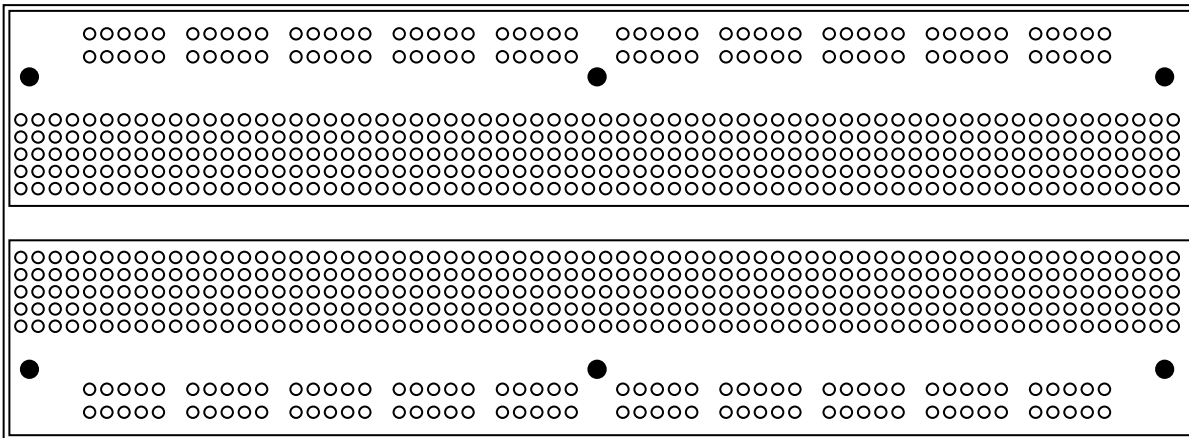
- A – First significant digit
- B – Second significant digit
- C – Exponent
- D – Tolerance

Resistance value: $R = AB \times 10^C$

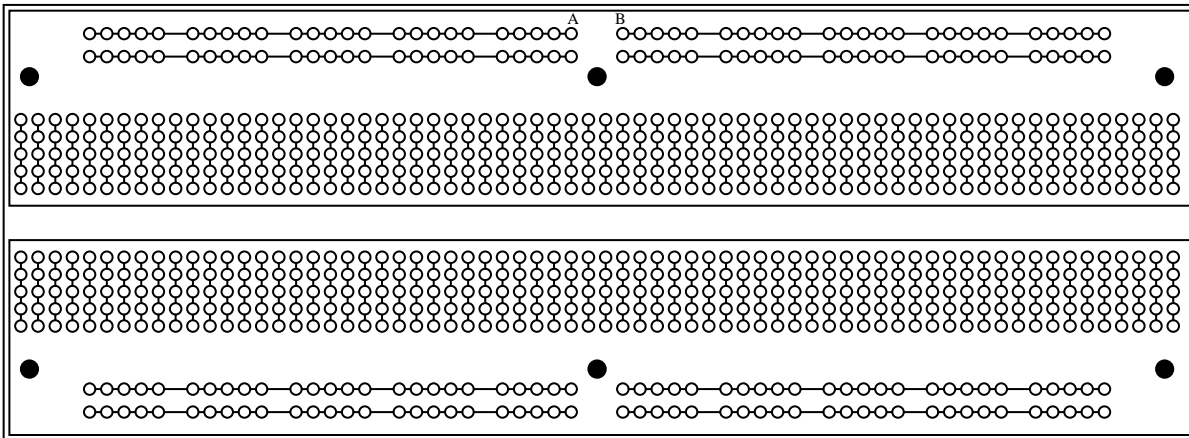
Ex: Green, Blue, Red, Silver
 $R = 56 \times 10^2 = 5.6 \text{ k}\Omega$. 10% tolerance

The size of a carbon resistor indicates its power rating.





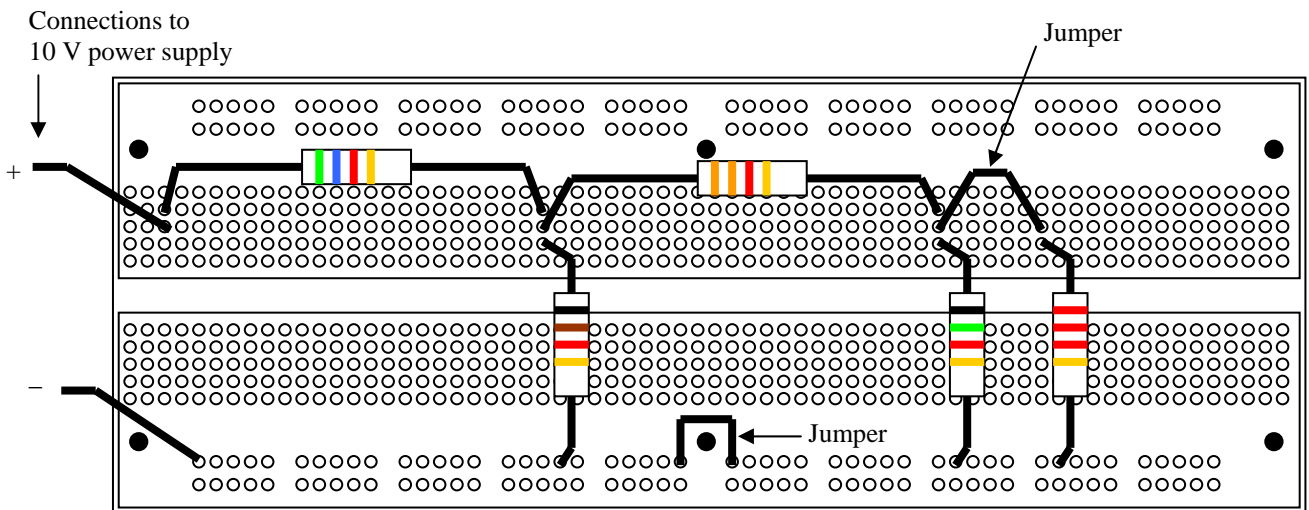
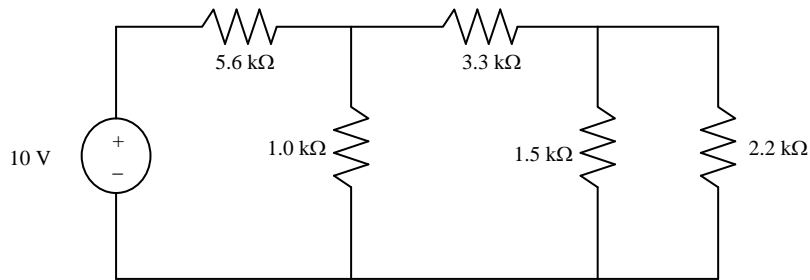
SK-10 Solderless Breadboard (or equivalent)



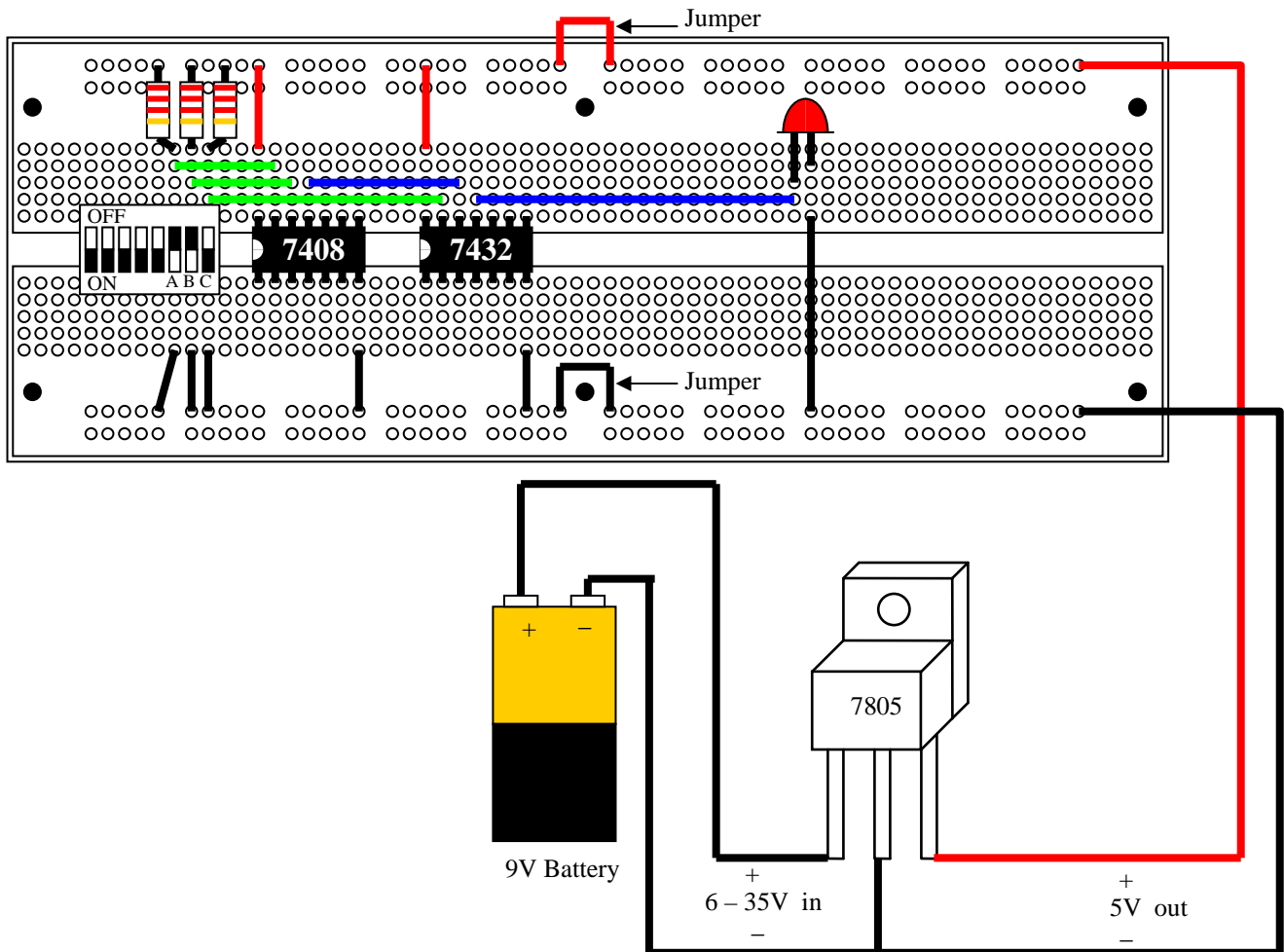
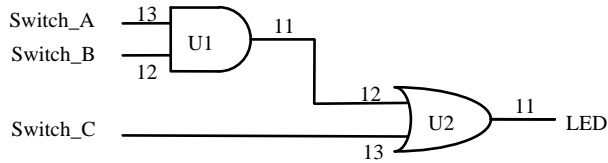
Internal Connections on the SK-10 Solderless Breadboard

- Notes:
- 1) Lines indicate which holes are connected under the breadboard.
 - 2) To connect two or more wires together, plug them in the same row of holes.
 - 3) Holes A and B are connected on some breadboards (as well as the similar holes on the other horizontal rows).

Example: Connect the following circuit using the SK-10 solderless breadboard.



Example: Connect the following circuit using the SK-10 solderless breadboard.



Notes:

- 1) The DIP switch operates as follows:
 - ON – Provides a logical 0 (LOW). Closed switch makes connection to ground.
 - OFF – Provides a logical 1 (HIGH). Open switch provides 5V through the 2.2k resistor. (It is often useful to install the switch *upside down* so that ON (LOW) is on the bottom.)
- 2) The switch positions shown above (darkened) provide an input of 110 causing the red LED to light indicating that the output is logical 1 (HIGH).
- 3) Cutting wires to length and using a wire color scheme makes for a neat circuit that is easy to troubleshoot. In the circuit above the following color scheme was used:
 - RED – 5V
 - BLACK – Ground (0V)
 - GREEN – Switch connections
 - BLUE – Other connections