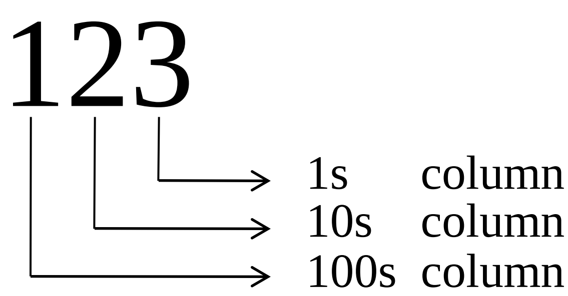
Electronics Merit Badge

Class 3

Decimal – Base 10

- In base 10, there are 10 unique digits (0-9).
- When writing large numbers (more that 1 digit), each column represents a value 10 times larger than the previous column.
- We say, how many 1's, how many 10's and how many 100's are there?



There is 1 '100' and
2 '10's and
3 '1's,
Making this number equal to one hundred and twenty three.

Binary – Base 2

- In base 2 (binary) there are two numbers, 0 and 1.
- When writing large numbers (more that 1 digit), each column represents a value 2 times larger than the previous column.
- We say, how many 128s, how many 64s how many 32s, how many 16s, how many 8s, how many 4s, how many 2s and how many 1s are there?

1011

1s	column
2s	column
4s	column
8s	column

There is 1 ‘8’ and
1 ‘2’ and
2 ‘1’,
making this number equal to eleven.

Counting to 16 in Binary

number		16	8	4	2	1	Binary
0		0	0	0	0	0	00000
1		0	0	0	0	1	00001
2		0	0	0	1	0	00010
3		0	0	0	1	1	00011
4		0	0	1	0	0	00100
5		0	0	1	0	1	00101
6		0	0	1	1	0	00110
7		0	0	1	1	1	00111
8		0	1	0	0	0	01000
9		0	1	0	0	1	01001
10		0	1	0	1	0	01010
11		0	1	0	1	1	01011
12		0	1	1	0	0	01100
13		0	1	1	0	1	01101
14		0	1	1	1	0	01110
15		0	1	1	1	1	01111
16		1	0	0	0	0	10000

Hexadecimal

- Hexadecimal represents numbers as base 16.
- It is easier to write and read a large number by describing it in hex rather than in binary.
- Each number column is a power of 16 higher.
- The digits for hexadecimal are 0-9, A,B,C,D,E,F.

123

→ 1s column
→ 16s column
→ 256s column

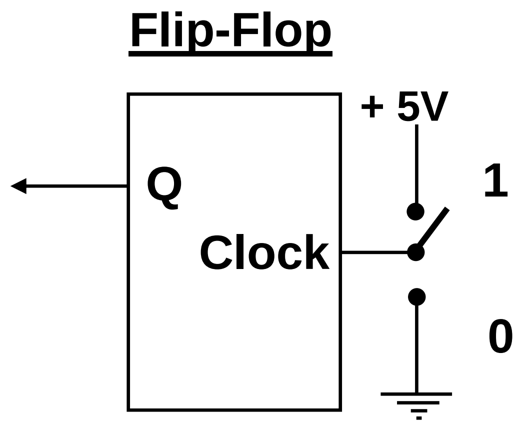
There are 1 '256' and
2 '16's and
3 '1's,
making this number equal to 291.

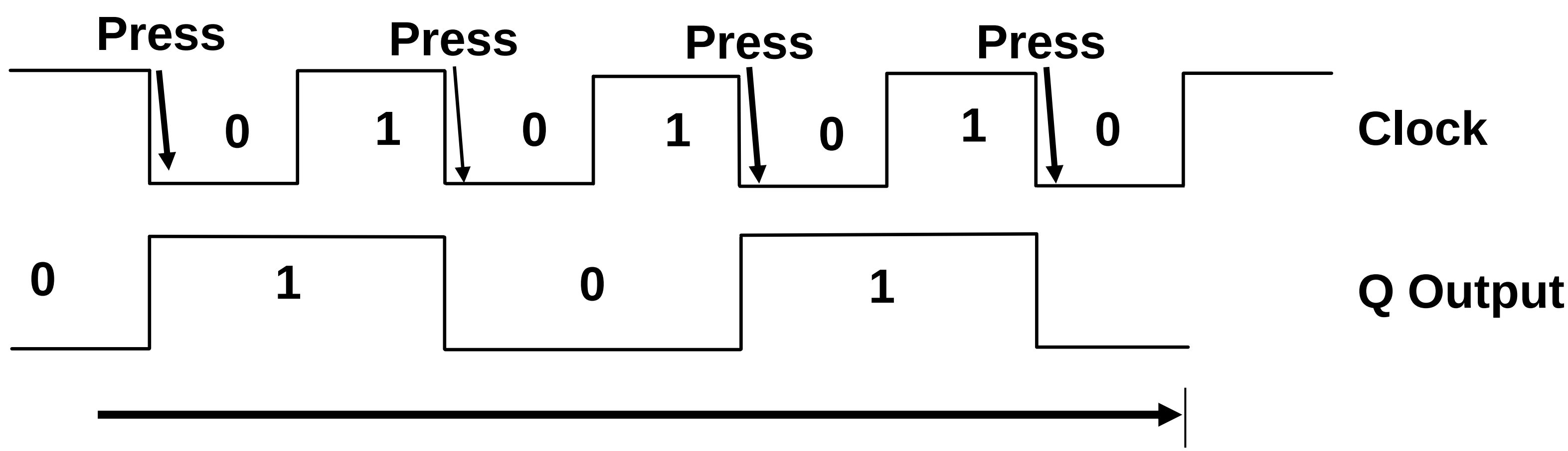
Counting to 16 in Binary AND Hex

Decimal	16	8	4	2	1	Binary	Hex
0	0	0	0	0	0	00000000	0
1	0	0	0	0	1	00000001	1
2	0	0	0	1	0	00000010	2
3	0	0	0	1	1	00000011	3
4	0	0	1	0	0	00000100	4
5	0	0	1	0	1	00000101	5
6	0	0	1	1	0	00000110	6
7	0	0	1	1	1	00000111	7
8	0	1	0	0	0	00001000	8
9	0	1	0	0	1	00001001	9
10	0	1	0	1	0	00001010	A
11	0	1	0	1	1	00001011	B
12	0	1	1	0	0	00001100	C
13	0	1	1	0	1	00001101	D
14	0	1	1	1	0	00001110	E
15	0	1	1	1	1	00001111	F
16	1	0	0	0	0	00010000	10

FLIP-FLOP

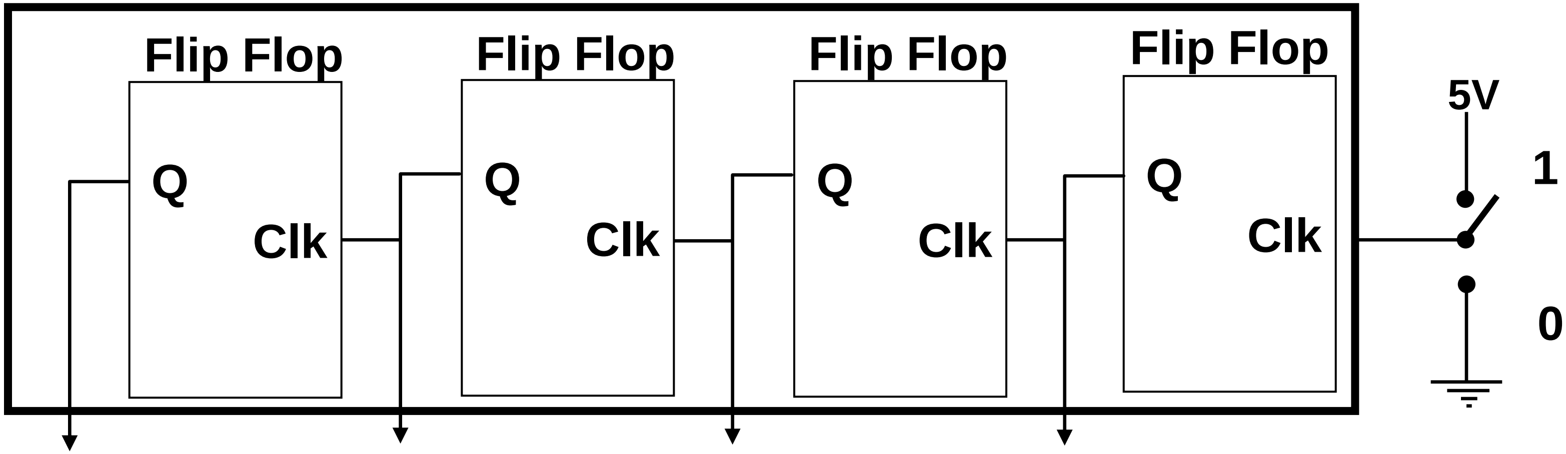
Press the switch, the clock goes to 0 volts (logical 0).
Release the switch, the clock goes to 5 volts (logical 1).
The output (Q) changes state on each 1 to 0 transition of the clock.
A flip-flop basically divides the clock by 2. It takes 2 clock transitions to make the output change once.





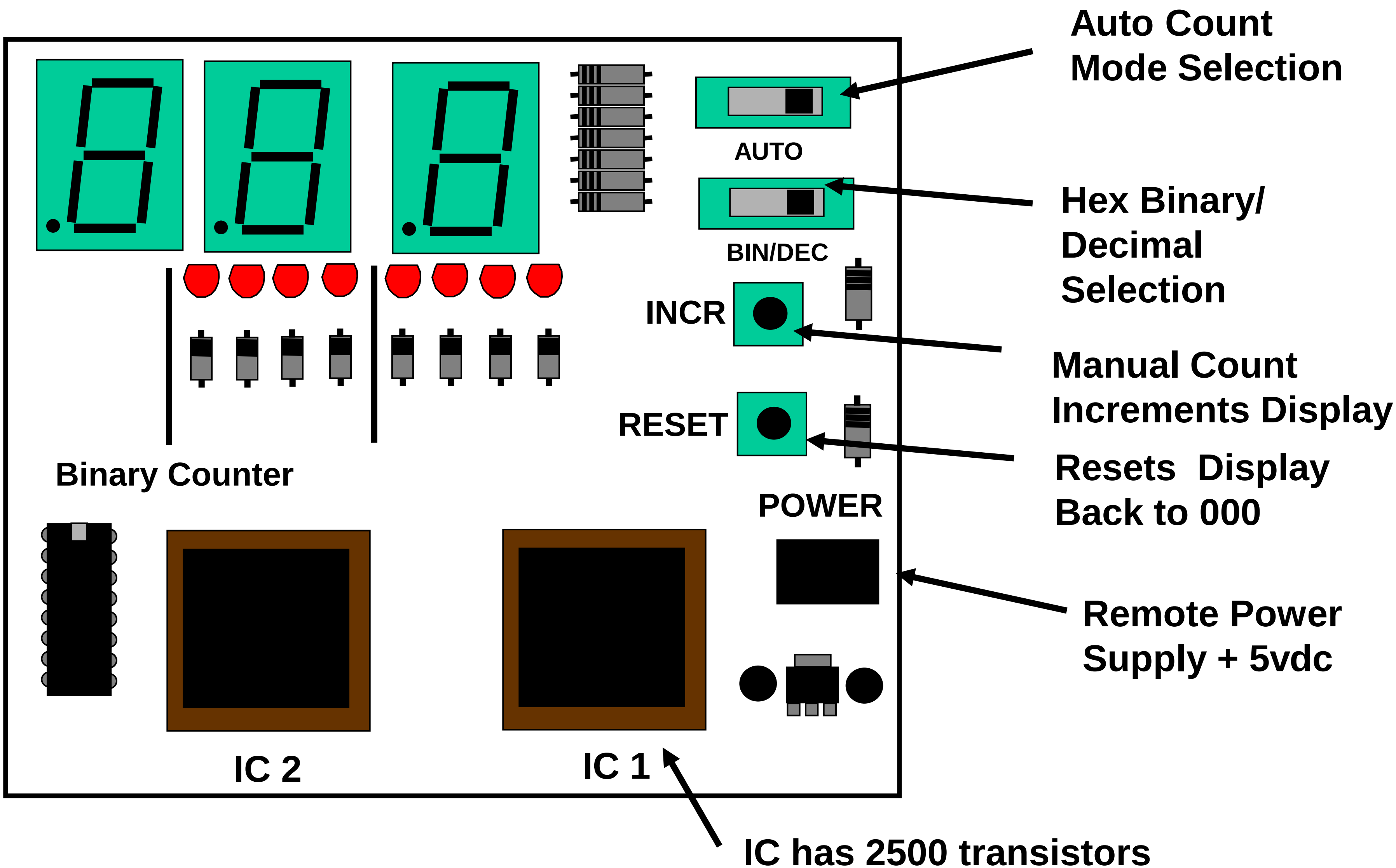
Binary Counter using Flip-Flops

4 Bit Binary Counter

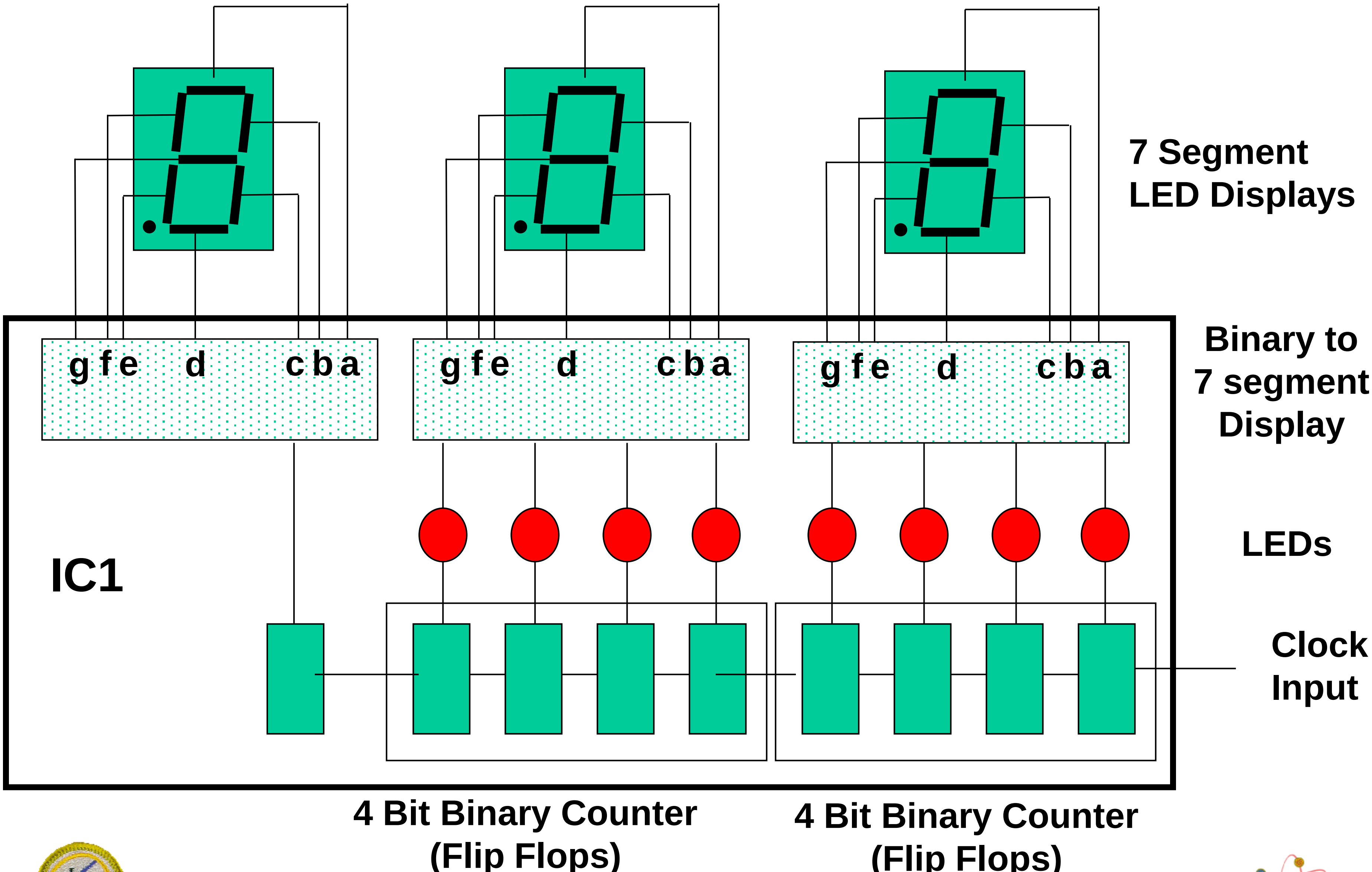


0	0	0	0	press
0	0	0	1	press 1
0	0	1	0	press 2
0	0	1	1	press 3
0	1	0	0	press 4
0	1	0	1	press 5
0	1	1	0	press 6

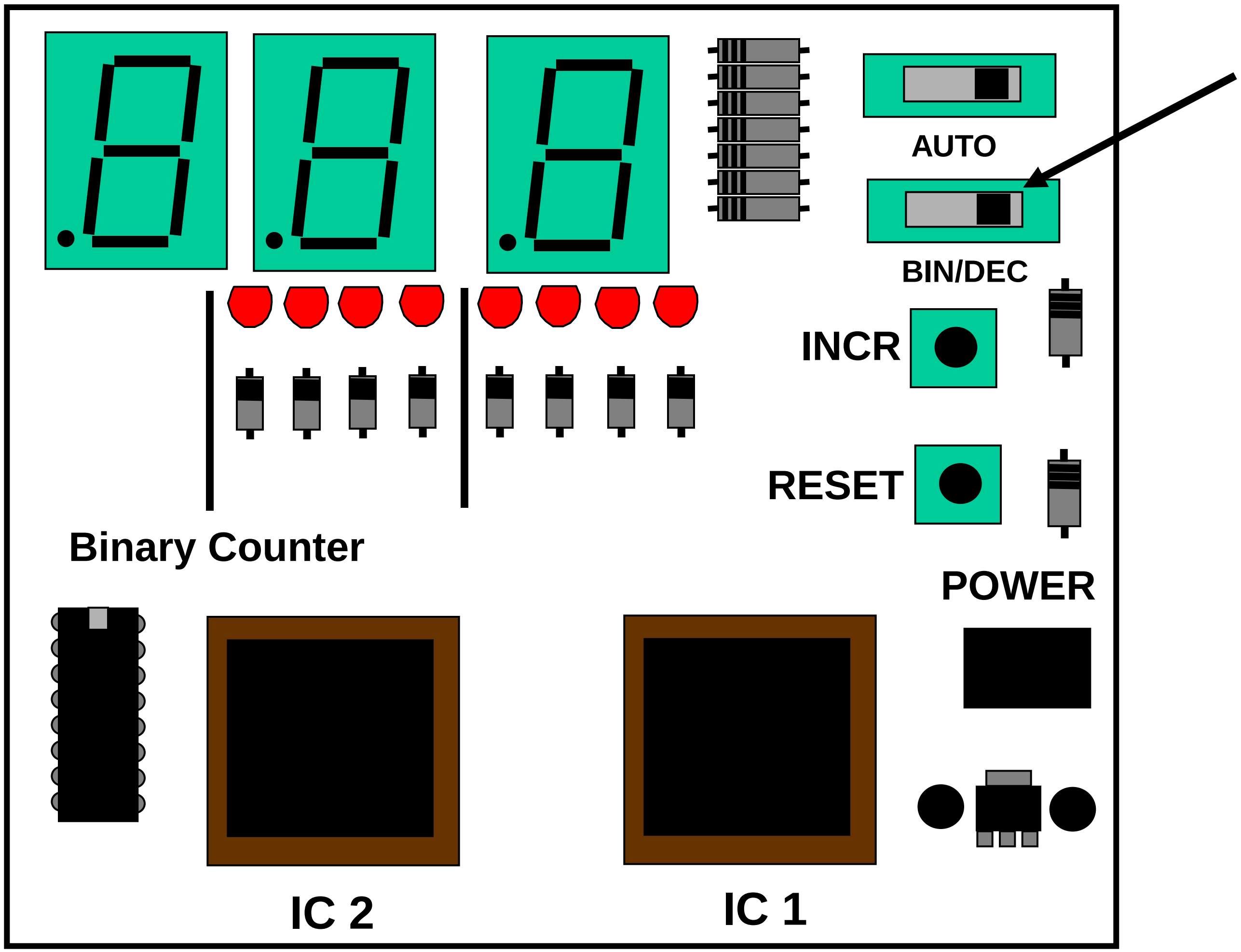
Binary Tool Kit



Binary Tool Kit Design
How it works



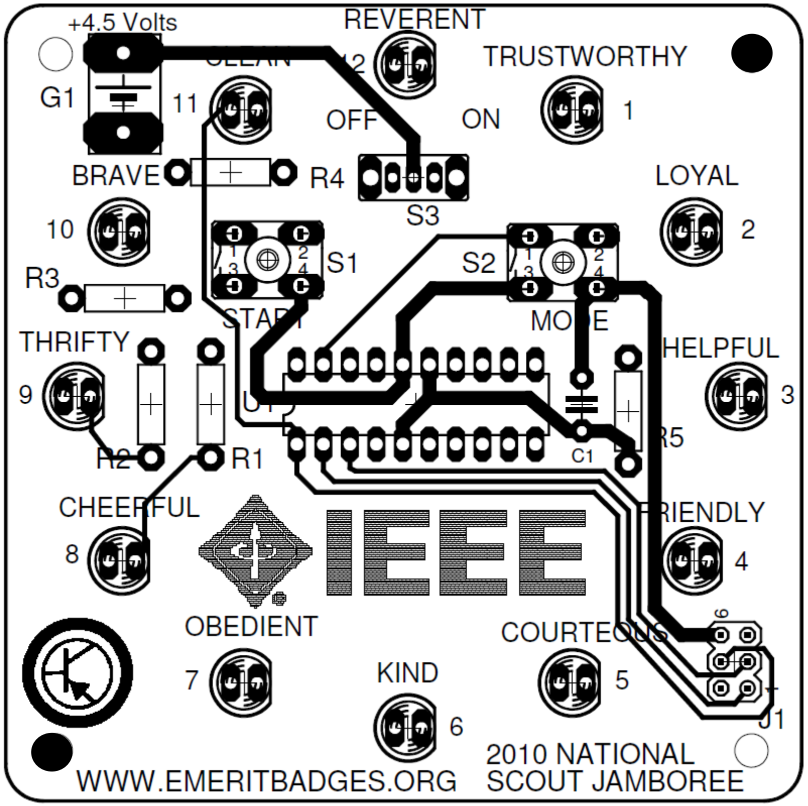
Binary Tool Kit
Use Tool to find Answers



Decimal Count

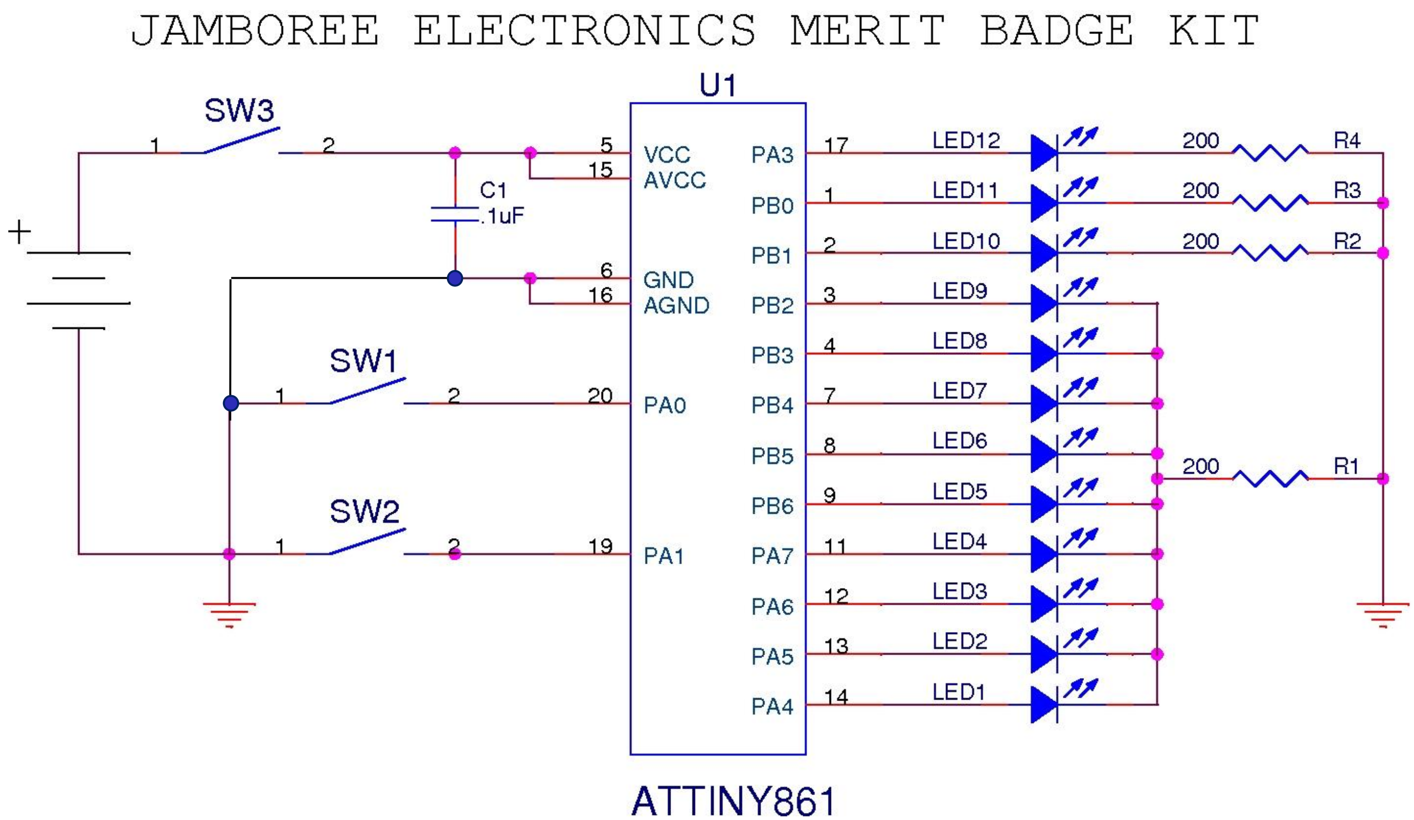
0000 =0 0
0001 =0 1
0010 =___
0011 =___
0100 =___
0101 =0 5
0110 =0 6
0111 =0 7
1000 =0 8
1001 =___
1010 =___
1011 =___
1100 =___
1101 =1 3
1110 =1 4
1111 =1 5

Microprocessor Controlled Counter



The kit contains a microprocessor that will drive 12 LEDs in a diminishing pattern. The LEDs can be displayed in many different modes, though each mode starts as a fast pattern, and eventually slows to a stop.

Microprocessor Controlled Counter



Microprocessor Controlled Counter Circuit
Draw the Schematic / Connect the lines