Flip Flop BCD Counter

ELECTRONICS123

Skill Level: Beginner

OVERVIEW

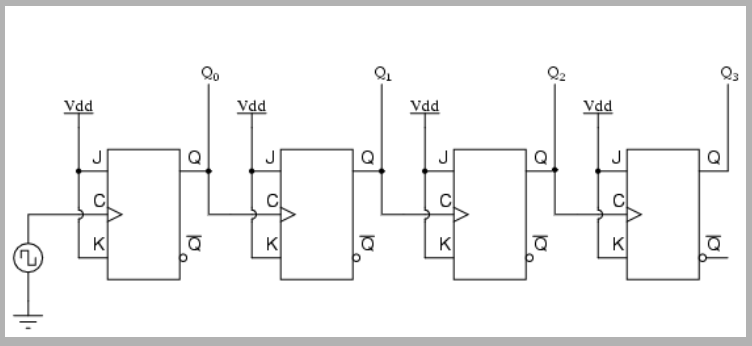
The Flip Flop Counter discussed in this article is a Asynchronous counter and will give an output in BCD (Binary Coded Decimal). The amount of bits will be determined on the number of flip flops cascaded, each flip flop will produce one bit. The first flip flop from the clock input will be the LSB (Least Significant Bit).

Flip Flop counters are extremely fast as it's a basic circuit constructed of logic gates, logic gates are made from transistors connected in specific means to form functions.

The counter can count up or down which will be discussed later on.

Although a switch could be used for the clock input it often and in most cases will have de-bounce, now since the counter reacts so fast one button push could count 5, 10 or many times, due to this a switch will need a debounce circuit or a NE555 pulse extender (Mono stable) circuit could be used for and digital inputs. If we had an IR beam it would be useful to use the NE555 as it will give a clean signal to the clock input.

Figure1: Flip Flop Counter Circuit



THE FLIP FLOP

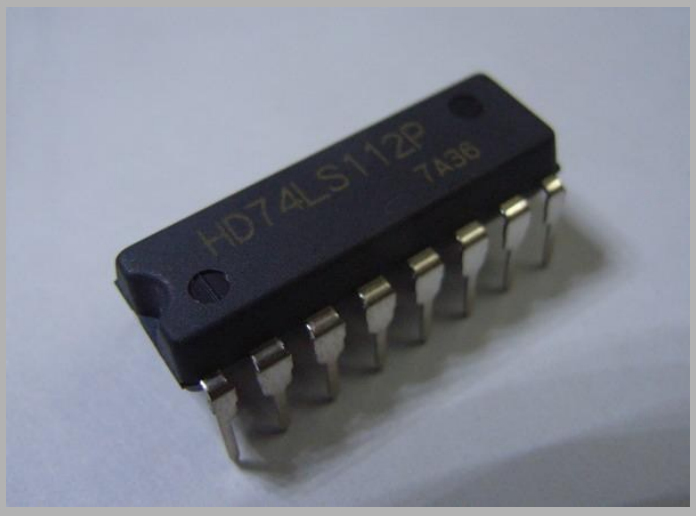
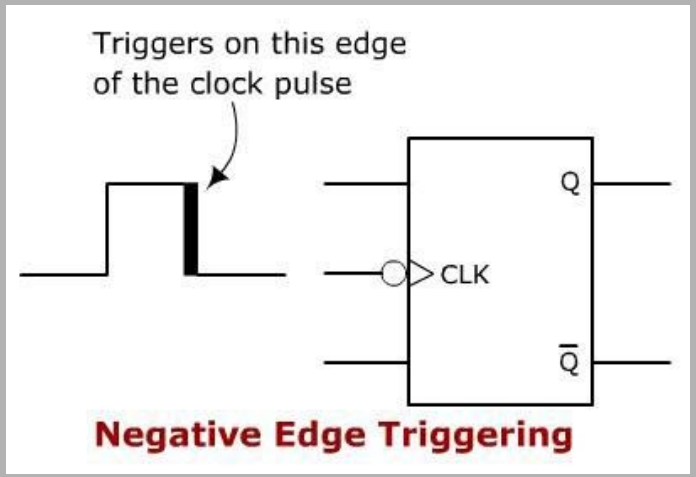


Figure 2: Flip Flop IC (DIP 16 package)

In Figure 2 is a 74LS112 Negative edge triggered Duel flip flop IC we will use 2 IC's as this will give us 4Bits that we can work with and use on the 7 Segment display driver.

The Negative edge triggered means that on a Square wave as an example, it will only change states once the clock pin has been changed from a high to a low (5V to 0V).

Figure 3: Negative Edge triggering



The Negative edge triggering of the flip flop can be seen with the little bubble on the clock pin, if no bubble is present it is a Positive edge triggered clock input.

Next we must have a look at the J and K pins, named after the inventor Jack Kilby. The J K pins determine the state the flip flop should be in. The following truth table will make it more clear.

Figure 4: JK-Flip Flop truth table

* ↓ = Negative Edge
* Q' (Q Compliment) = Opposite of Q

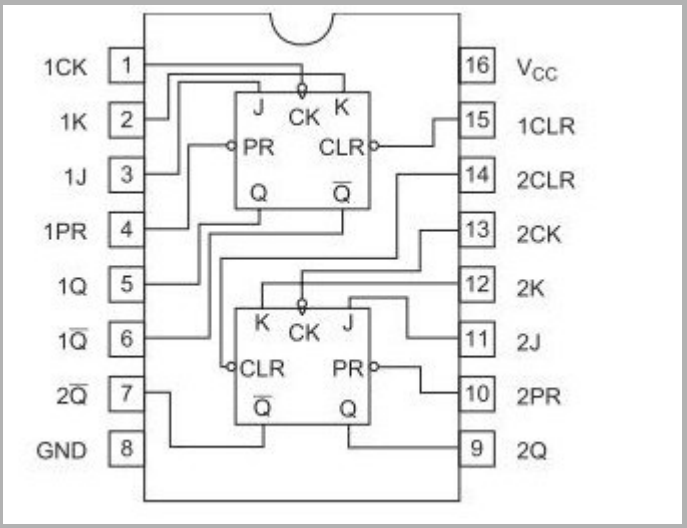
  (If Q = 1 then Q' = 0)
* NC = No Change
- RST = RESET , Q = 0
- SET = PRESET, Q = 1
- TOGGLE = Q always changes to its Compliment state, thus if Q = 1, the clock will make it 0, if clocked again it will change it back to 1.

INPUTS			OUTPUTS		STATE
J	K	C	Q	Q'	
0	0	↓	Q	Q'	NC
0	1	↓	0	1	RST
1	0	↓	1	0	SET
1	1	↓	Q'	Q	TOGGLE

For the flip flop counter we will have to set the flip flop into a toggle state, this state acts as a simple frequency divider. To achieve this we connect the J and K pins to 5V this sets the flip flop into toggle state.

For this experiment we will tie the reset and preset pins to 5V as we do not want to use them, the reset and preset pins are active low so 0V to activate the function and 5V to deactivate the function.

Figure 5: 74LS112 Flip Flop Pin Out



PIN DEFINITIONS:

- Pins(1, 13) = clock input pins this is where the pulse will go in and the negative edge gets sampled.
- Pins(2, 12) = K input pins.
- Pins(3, 11) = J input pins.
- Pins(4, 10) = Preset pins (Active Low) sets output Q to 1.
- Pins(5, 9) = Q outputs.
- Pins(6, 7) = Q compliment outputs.
- Pin(8) = GND
- Pin(14, 15) = Clear pins (Active Low) sets output Q to 0.
- Pin(16) = VCC Supply Voltage (+5V).

BCD COUNT

The Flip Flops generate a BCD code due to the frequency division characteristics of the toggle state flip flop. As you can see in the binary truth table the frequency division makes it possible to obtain relevant data from the flip flops.

BCD TRUTH TABLE

	DATA INPUTS			
Decimal	**D (MSB)**	**C**	**B**	**A (LSB)**
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

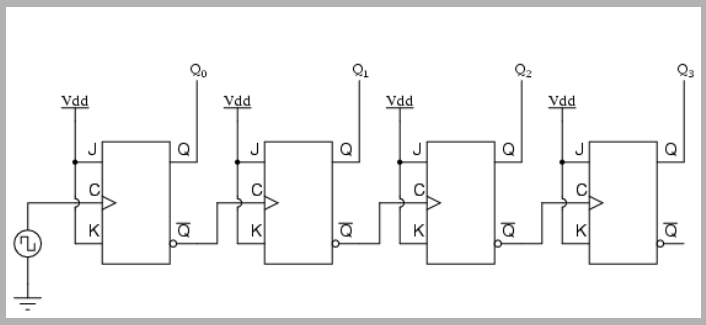
Have a look at the binary truth table, the green represents the 1's. As one can see the LSB has the most changes between 0 and 1, so the LSB (A) has the highest frequency and B will be half that frequency and C will be half of B's frequency and so on. This is how the basis of the flip flop binary counter works. The BCD code can be fed into a display driver etc. to make it show decimal numbers that's counting.

DOWN COUNTER

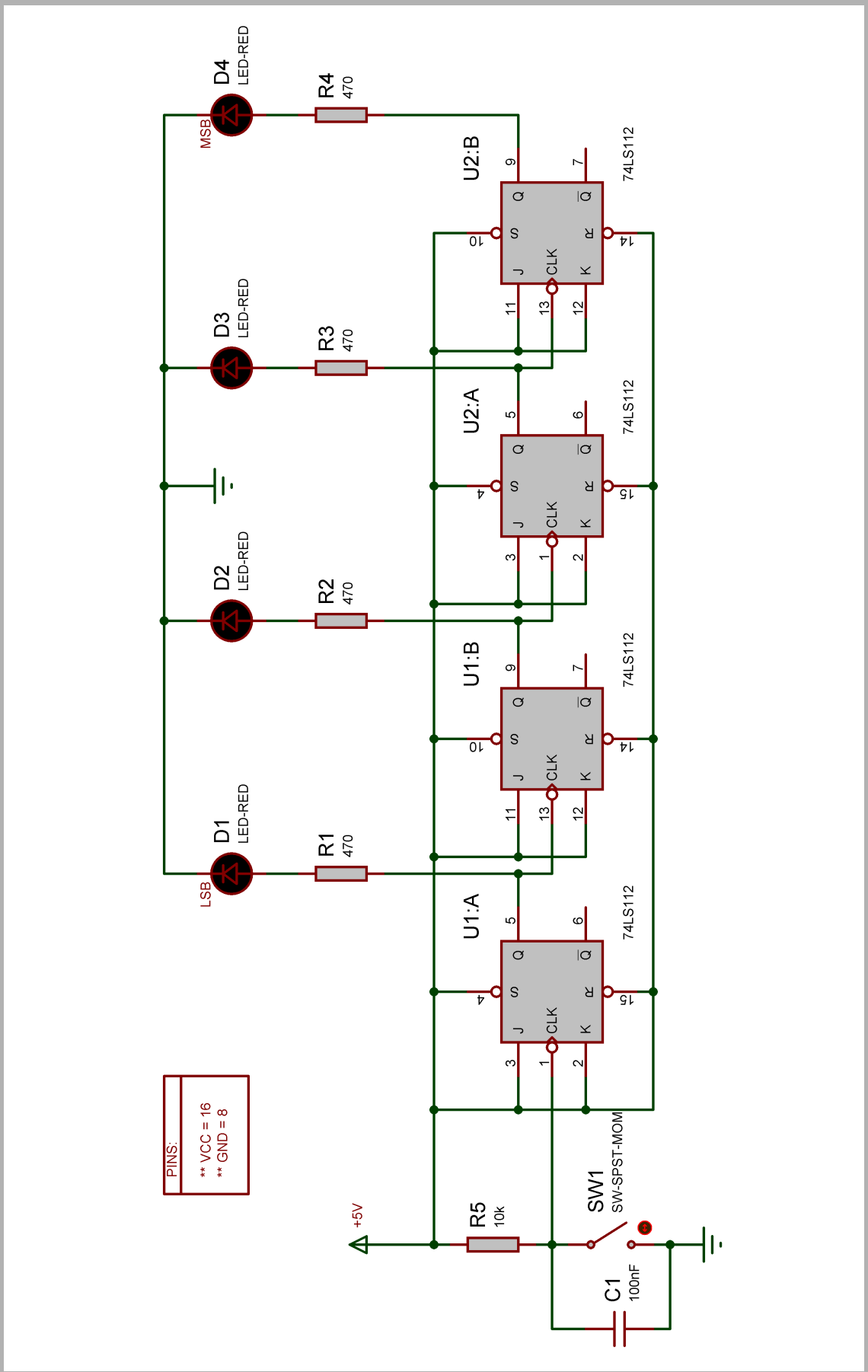
So far we have constructed a counter that's able to count from 0 to 15. The down counter will decrement from 15 to 0 this could be useful for other applications where up and down counters can be used. It is possible to make a UP/DOWN counter from 4 Flip Flops although some external circuitry will be needed to switch in-between.

The down counter is the same layout as the up counter in figure 1, all that will change is the clock pin from the proceeding flip flops will receive a signal from the Q compliment not Q pin any more, as you should remember Q compliment is opposite of Q thus causing different patterned effects.

Figure 6: Down Counter



FLIP FLOP UP COUNTER



TROUBLE SHOOTING

Once the circuit has been constructed and any problems arise they could often be solved by a few simple checks as listed:

- **Nothings turning on:**

  Make sure the Reset pin is connected to +5V and check connections to LED's.

- **Not counting properly:**

  Try increase the capacitors value on the debounce circuit, or incorporate an NE555 with a low frequency e.g.: 10 Hz to prevent false triggering

PARTS LIST

ELECTRONICS 123 Stock codes:

Quantity	Description	Stock Code
1x	74LS112 Flip Flop IC	AC883
1x	7 Segment Display C/A	AA027
4x	LED 5mm	AA380
4x	470 Ω 1/4 Watt Resistors	DB049
1x	Switch	GB189

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