4-bit Binary Counter with Automatic Direction Reverse

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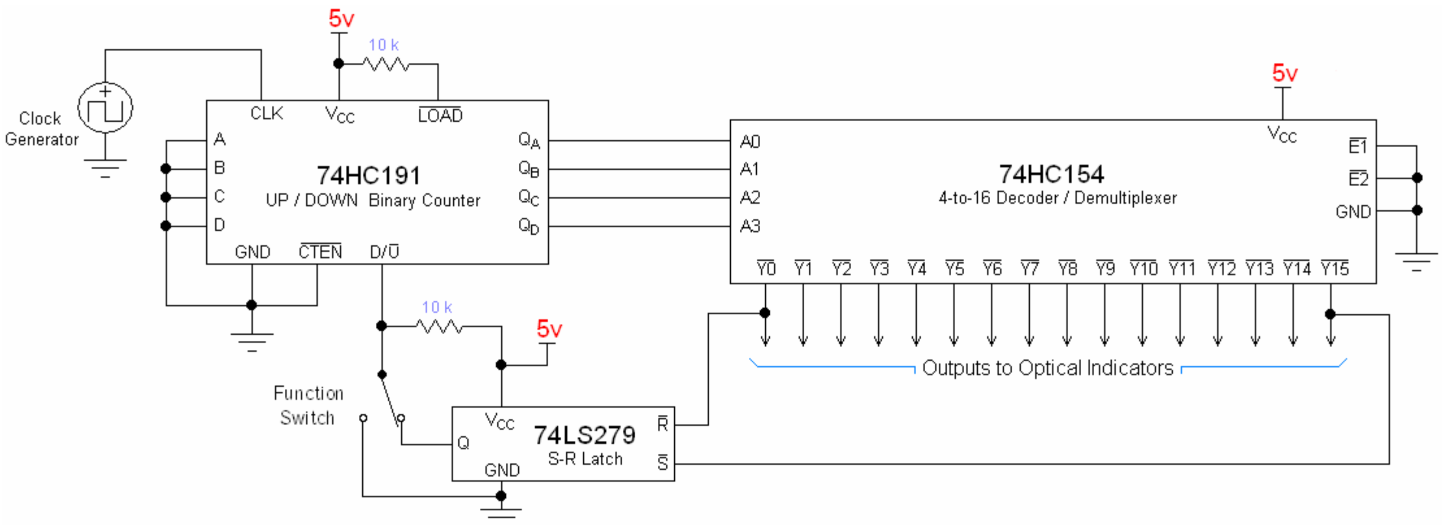
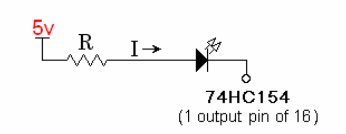


When power is first applied to the circuit, the binary output of the '191 counter is randomly generated by the four internal flip-flops. The device will then begin counting with the rising edge of the clock pulses, in a direction determined by the state of the D/U pin. The 4-bit binary output of the '191 counter is decoded by '154 which triggers the corresponding output to momentarily pulse low.

The count direction pin (D/U) is determined by the output of the '279 S-R latch. When the counter reaches the minimum value (0), the '154 decoder triggers the corresponding output pin (Y0), causing the S-R latch to reset the count direction to increment. When the counter reaches the maximum value (15), the decoder's (Y15) output is triggered, setting the count direction back to decrement. This arrangement causes the '191 to repetitively reverse directions at its endpoints, counting infinitely back and forth along its 4-bit (0-15) domain.

This type of electronic counting function is commonly used to generate moving light displays. For example, the decoder's sixteen outputs could each be connected to one of sixteen corresponding light indicators. Positioning these lights consecutively in a line would create the effect of a spot of light moving back and forth along the line as the '191 counted.

For an added capability, a SPDT (center off) switch can be used to control the counting function. In the switch's current position, the D/U pin is controlled by the '279 latch, so the counter is in the "auto-reverse" mode. When the switch is in the center position, the 10kΩ pull-up resistor brings the D/U pin up to a high logic value, setting the counter to "decrement" mode. With the auto-reverse function disabled, the counter will reach a maximum or minimum and start back from the other end, always counting in the same direction. When the switch is pushed all the way to the left, the D/U pin is grounded, causing the counting direction to switch to "increment" mode.

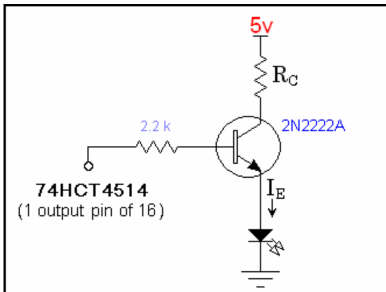


R	I
820Ω	3.6mA
560Ω	5.2mA
330Ω	8.8mA
220Ω	13mA
180Ω	16mA
150Ω	18mA

Figure 2 Low Current LED Indicator (1mA to 15mA)

The most common method of optical indication when dealing with logic devices are LEDs (Light Emitting Diodes). Figure 2 illustrates a very basic yet affective light indicator circuit. The '154 decoder's outputs are normally in the high logic state and they pulse low when triggered by the counter. So in normal operation, the voltage at the '154 output pin is around 4 volts, placing a potential across the LED that is of insufficient magnitude to allow current to flow. When the output pin is triggered, the LED's cathode is pulsed to a low logic state, allowing the diode to sink current into the decoder's output, and momentarily light up.

The '154 outputs can sink an absolute maximum current of 25mA, so just to be safe, it shouldn't be used to sink more than 20mA. If a higher power light indicator is required, the circuit in Figure 3 can be used to switch high intensity LEDs with load currents in excess of 100mA. This indicator puts a lesser demand on the decoder's outputs, consistently drawing a mere 1mA source current into the transistor's base when activated.



R_C	I_E
180Ω	17mA
150Ω	20mA
120Ω	25mA
100Ω	30mA
82Ω	35mA
56Ω	50mA

Figure 3 High Current LED indicator (1mA to 100mA)

Unlike Figure 2, this is a positive logic LED indicator triggered by a high logic pulse. To achieve the same "moving light" function, this indicator would have to be used on a decoder with outputs that are normally low. The '4514 4-to-16 decoder can perform this function. However, if the '4514 is to be used in place of the '154 decoder, a latch with positive logic S-R inputs would be required to maintain the auto-reverse function.