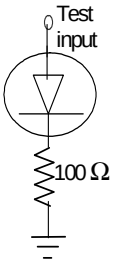

Figure 1. LED sensor.

Phy 415/515 Lab #12 Counter 2009

__1.Counter

___1.1.Power supply

Set the 0-20 side of the power supply to 5V. Create columns on the breadboard for +5, and ground.

___1.2. Wire the chip basics

The pin diagram for the 74191 counter is shown in Figure 3. Connect the power, +5 to pin 16 and ground to pin 8. "Cten," pin 4, is the count enable and must be grounded for the input to work. "D/U," pin 5, chooses whether the counter counts up or down, and should be grounded to count up. The counter has 4 latches, which remember the current state of the counter in order to add one at each clock pulse. QA "toggles"--goes low if it was high and vice versa, QB toggles if QA was high, etc.

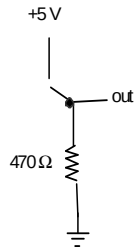

Figure 2. SPST DIP switch.

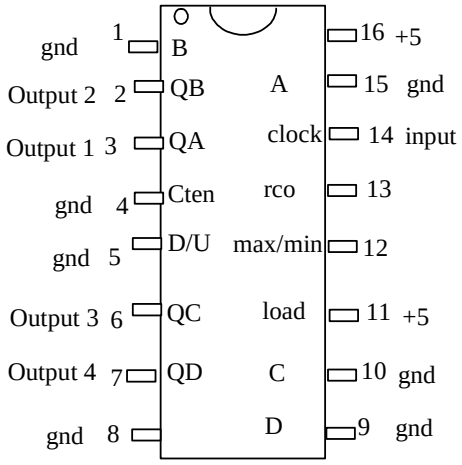

Figure 3. TTL binary counter 74191.

___1.3. Outputs

Wire 4 LED sensors, as shown in Figure 1. First test them by connecting the input to +5 or gnd and seeing whether the LED lights. Then connect them to read the outputs, QA, QB, QC and QD, of the counter chip.

___1.4. Load Input

Wire one SPST DIP switch, as shown in Figure 2 and test (using an LED sensor or voltmeter) that the output toggles from high to low with the switch. The "Load," pin 11, when grounded causes the output to go to preset starting values (inputs A-D). It should be connected to the DIP switch and set to +5. A-D (pins 15, 1, 10 and 9) should be grounded so that we can load a "zero" when we toggle the DIP switch. Test that all of the LEDs go off when the switch is toggled. Make sure that it is returned to +5. Pins 12 and 13 are overflow outputs that can be used as carry bits, but we can ignore them.

__2. Switch input for the counter

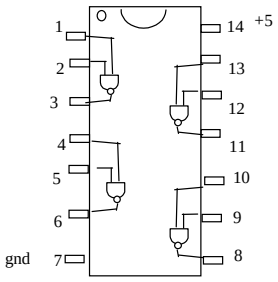

Figure 5. TTL Nand gate, 7400.

___2.1. Counter input that doesn't work properly

Wire the rocker SPDT switch, with one side to +5, the other to ground, and test that the output (middle wire) goes from high to low depending on the switch position.
Connect the switch output to the pin 14 input of the counter. Flip the switch back and forth to attempt to count from 0000 to 1111. Does it sometimes double count (or worse)?

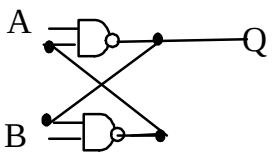

Figure 4. Flip flop constructed from TTl nand gates.

___2.2. Flip Flop

Wire the Nand gate, Figure 5, to make a flip flop, as in Figure 4.

___2.3. Switch debouncing

Connect the A and B inputs of the flip flop through a 100 Ω resistor to +5. Remove the rocker switch from the counter. Connect its center line to ground, and the two other lines to the A and B flip flop inputs. Test that Q toggles from low to high when you move the switch back and forth.

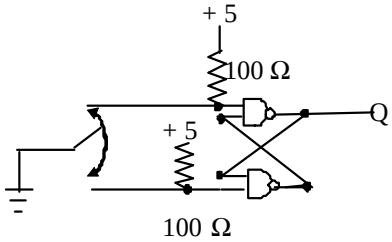

Figure 6. Debounced SPDT switch.

___2.4. Counter Operation

Connect output of the flip flop as the input to pin 14 of the counter. Has the double

counting been prevented? Count from 0 to 1111. What happens if you change “D/U” to +5? Return in to ground.

___3. 7 segment LED

___3.1. Read before wiring

The seven segment LED is meant to use inputs which go LOW when the segment should be lit. Pin 3 (or 8) is the common anode, which should be connected through a resistor to +5. To test how this works, connect ground to pin 7 and see that segment a lights. Remove the ground wire. The pin connections are shown in Figure 8.

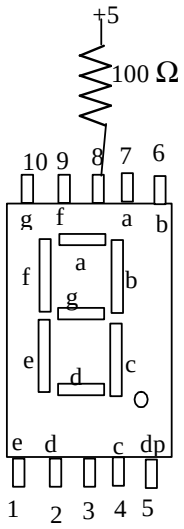

Figure 8. Seven segment LED.

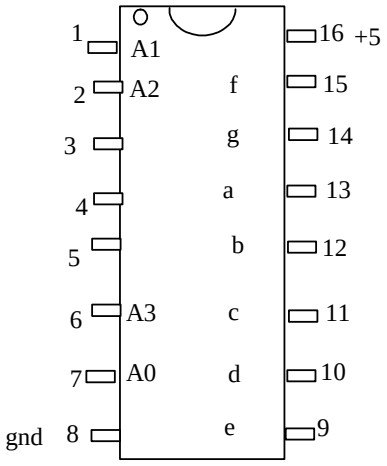

Figure 7. 7447 bcd to 7 segment with open collector outputs.

___3.2. BCD to 7 segment converter

Obviously, you could figure out the logic to decide which segment should be lit when which of the four binary output lines is high, but it takes a bunch of gates. A single package is available to do this. Unfortunately we don’t have one. We have a bcd (binary coded decimal) to 7 segment converter, which does the same thing, so long as the input is less than 10. The pin connections are shown in Figure 7. The ouputs (a-g) are meant to sink current, so they work well with the 7 segment LED. The inputs A0-A3 should be connected to the same counter outputs as our four free standing LEDs (A0 is the least significant bit).

___3.3. Count

Count from 0 to 9. Above 9 the chip doesn’t know what to do with the inputs, so the output is weird (except that it is designed to blank the LED when the input is 15).

___4. Logical Reset

Figure out a logic gate solution to reset the counter when it reaches 10. Hint: QD and QB are the 8 and 2 bit, respectively, the load input resets the counter when it is low, and you have a nand gate handy. Remember to disconnect the DIP switch output before you connect something else to the load input of the counter.