Introduction

In this lab you will design a digital circuit of moderate complexity. You will use a 555 timer to generate slow pulses, feed these into a 74LS90 decade counter, convert the counter output into a form suitable for driving a display using a 74LS347 (or 74LS47) decoder/driver, and use this output to drive a seven-segment LED display. The display will count from 0 to 9 at a rate determined by the 555 timer.

Equipment

Solderless breadboard (on the prototyping unit), resistors, capacitors, LEDs, a 7-segment common-anode LED display, and the following ICs: 555, 74LS90, and 74LS347 or 74LS47 (the latter two are almost the same thing.)

Procedure

- Read the information on the 74LS90 and 74LS347 ICs (National databook or whatever) and copy their pin-out diagrams in your notebook. You may also want to note their special function pins, such as the blanking input on the 74LS347. (Note: In the National Semiconductor data sheet book, there is a mistake in the pinout diagram of the 74LS47 and 74LS347 – they are corrected in pencil.)

- Using a 555 timer, design an astable multivibrator operating at about 1 Hz, with a duty cycle of roughly 90%. (Thus, the output will be high most of the time.) Use an approximately 30\(\mu\)F capacitor and appropriate resistors — the exact values are up to you. You may want to monitor the output using one of the LED indicators on the prototyping unit.

- Use the output of the 555 to clock a 74LS90 counter, hooked up as a decade counter. You may want to hook all four outputs to LED indicators, to make sure it is counting correctly.

- Next, the \(Q_A\) through \(Q_D\) outputs of the 74LS90 go to a 74LS347 (or 74LS47) decoder/driver. The a, b, \ldots g outputs of the driver will go to a seven-segment LED display.

- The LEDs in the seven-segment display are in a common anode configuration. Use any of the display modules shown in the diagram; your choice. Top views are shown.
The output from the 74LS347 is open collector, as shown by the data book. Thus, a segment of the display will be on when the output to it from the 74LS347 is low. Be sure to use a 330Ω resistor with every output so that you don’t exceed the maximum current capacity of an LED segment and burn out the display. Instead of using separate resistors, it is convenient to use 330Ω resistors in a 14-pin DIP package. They are labeled “914C331X5SR”. You may verify with an ohmmeter that the resistors connect pins 1 and 14, pins 2 and 13, 3 and 12, etc. (We also have some light-blue-colored 330Ω DIP resistors, but these cannot be used since the resistors are not separate — pin 16 is common to all resistors.)

- **Use despiking capacitors on the LS TTL chips!** Any common capacitors, 0.01 to 0.1 μF will do. If you don’t do this, your circuit will probably not work properly.

- Overall, you will have something like this:

**Construction hints**

1. As I hope you have already been doing, it is good practice to establish one of the strips on the breadboard as a +5 v bus and another as a ground bus. This facilitates making many of the connections to the ICs.

2. Check each part of the circuit as you complete it, before moving on to construct the next part. You may check output levels with an LED in series with a resistor, with a voltmeter, or with a logic probe – I suggest that you become familiar with the use of these.
3. The rat’s-nest wiring technique (which some of you have been using) will cause headaches here. Try to run the wires either parallel or perpendicular to the busses, with right angle bends, and keep them close to the surface of the breadboard. That way the wiring is easier to debug and you can change chips conveniently if one of them is bad.

The write-up

- Include a complete circuit diagram. Explain in a few sentences the operation of the circuit. Indicate why certain pins on the digital ICs are permanently set high or low (e.g., the blanking input on the 74LS347.)
- Indicate whether or not the circuit worked as intended.
- **Problem:** show (with a diagram) how to use a 74LS190 counter to replace the 74LS90.