Experiments for the

Lab9500

Experiment 223
- The Traffic Light Project -

Purpose: To design a complete digital system that will function as a traffic light.

The Lab9500 was designed to implement almost any modest digital system that one might encounter in an entry-level design course. The Lab9500 also has enough built-in I/O to build a reasonable, functional traffic light. While a traffic light might seem to be rather cliché, it illustrates many functions found in digital design.

The traffic light is meant to be the culmination of a series of experiments which when put together will make a full-functioning traffic light. The experiments are meant to be complete in themselves. When combined they will need to be modified to reflect their function in the complete system.

Eight I/O pins are connected directly to a bank of eight LEDs along the top of the board. While these might be dedicated to a single traffic light function, a better usage is to make what they select switch selectable. Accordingly, even though they may not have another use for one of the experiment modules, we would like to refrain from using them as outputs specific to the application, but rather to use them to reflect the outputs.

Here is a list of experiments leading up to the traffic light.

1. Using the 60Hz power input to the board, apply the squared-up and debounced 60 Hz signal to an input and design a divide by 15 counter using T flip-flops to obtain a 4 Hz clock. Use two additional T-flip-flops to obtain 2 Hz and 1 Hz signals. Drive the LED outputs L0 through L5 with the LSB of the four-bit divide-by-15 counter on L0 and the 1 Hz signal on L5.
2. Design a six-state state machine that implements a simple traffic light with overlapping reds that controls a RED, AMBER and GREEN LED in two orthogonal directions. Decode the states to drive the LEDs. Step the traffic light state machine with a pushbutton.
3. Design a 5-bit down-counter using T-flip-flops. Load the counter with the five least bits of the DIPswitch. The counter should count the number of counts in the DIPswitches.
4. Design a 5-bit up/down counter that counts using pushbutton PB1, and uses PB3 to determine the UP or DOWN direction of the counting.

5. Combine all of the experiments above to get a six-state traffic light with the following requirements:
    a. A 1 Hz clock per experiment 1 above will clock the state machine and the down counter.
    b. The number loaded into the down counter will be determined by the current state when the down-counter times out. The overlapping red times and the amber times will be fixed.
    c. The time for the long green and short green will come from two separate up/down counters.
    d. The contents of the 8-bit LED display will be determined by two DIPswitches. With both low, the down-counter for the traffic light is displayed. When S0 is high, the up/down counter representing the long green time is displayed. When S1 is high, the up/down counter representing the short green time is displayed.

In a later experiment, additional features will be added to the traffic light.